0093674

DOE/RL-2007-27

DRAFT C

SECTION

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Appendix B

Screening-Level Ecological Risk Assessment

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Terms

DOE	U.S. Department of Energy
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
ERAGS	Ecological Risk Assessment Guidance for Superfund
OU	Operable Units
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
SLERA	screening level ecological risk assessment
UPR	unplanned release
WAC	Washington Administrative Code
WIDS	Waste Information Data System database

Appendix B

Screening-Level Ecological Risk Assessment

B1.0 200-PW-1/3/6 Operable Units Ecological Risk Assessment

A screening level ecological risk assessment (SLERA) was performed for all 17 sites in the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units (OUs) following EPA 540-R-97-006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments: Interim Final* (ERAGS) and the Terrestrial Ecological Evaluation (TEE) procedure presented in WAC 173-340-7490. Waste sites were considered with regard to exposure potential for plants and animals. The 17 waste sites in the 200-PW-1, 200-PW-3, and 200-PW-6 OUs are listed in Table 1-1 of the main text and described further in Section B2.0.

The SLERA steps focus the assessment and determine whether the potential for exposure or risk to ecological receptors warrant further investigation. The most critical aspect of an ecological screen is problem formulation. This is the systematic planning incorporated into the beginning of the risk assessment process that identifies the major factors to be considered and is linked to the regulatory and policy contexts of the assessment.

Problem formulation involved reviewing relevant site records (e.g., Waste Information Data System [WIDS]) as a first step to assess existing data on waste site conditions pertinent to ecological exposure. This information was considered before the site visit was undertaken (ERAGS Step 1). As noted in ERAGS, a possible outcome of the site visit is a determination that present or future ecological impacts are negligible because complete exposure pathways do not exist. This is an important determination, and the guidance emphasizes all sites should be evaluated by qualified personnel to determine whether this conclusion is appropriate. In accordance with this guidance, the principal authors of the Central Plateau ecological DQOs (WMP-20570) and sampling and analysis plans (DOE/RL-2004-42) evaluated whether complete exposure pathways exist for the 200-PW-1, 200-PW-3, and 200-PW-6 OU waste sites.

Evaluating potential exposure pathways is one of the primary tasks of the screening-level characterization of a site. For an exposure pathway to be complete, a contaminant must be able to travel from the source to ecological receptors and be taken up by the receptors via one or more exposure routes. If an exposure pathway is not complete for a specific contaminant, the exposure pathway does not need to be evaluated further.

Information is provided in Table B-1 for the deeper-rooted plant species and deeper burrowing mammal and ant species occurring on the Hanford Site (PNL-2774, *Characterization of the Hanford 300 Area Burial Grounds: Task IV – Biological Transport*; RHO-SA-211, *Intrusion of Radioactive Waste Burial Sites by the Great Basin Pocket Mouse* (*Perognathus parvus*). None of the maximum depths reported for plant or animal species were greater than 3 m (10 ft), above the 4.6 m (15-ft) interval defined for applicability of shallow-zone screening thresholds (WAC 173-340-7490[4][b]), which indicates the pathway from deep soil to ecological receptors is incomplete. The Hanford Site-specific data indicate the shallow-zone soil (<4.6 m [15 ft] bgs) is the primary contaminated medium of concern for ecological receptors. Waste sites were considered inaccessible to ecological receptors under either current or future conditions if the contamination was deeper than 4.6 m (15 ft) bgs.

Table B-1. Maximum Plant-Rooting and Burrowing Depth for the Hanford Site Receptors

Species	Maximum Depth		Reference
	(cm)	(ft)	
Plants			
Antelope bitterbrush	300	9.8	PNL-5247
Big sagebrush	200	6.6	PNL-5247
Spiny hopsage	195	6.4	PNL-5247
Russian thistle	172	5.6	PNL-5247
Mammals			
Great Basin pocket mouse	200	6.6	RHO-SA-211
Soil Biota			
Harvester ants	270	8.8	PNL-2774

Source:
PNL-2774, *Characterization of the Hanford 300 Area Burial Grounds: Task IV – Biological Transport.*
PNL-5247, *Rooting Depth and Distributions of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site.*
RHO-SA-211, *Intrusion of Radioactive Waste Burial Sites by the Great Basin Pocket Mouse (*Perognathus parvus*).*

In considering the subsurface extent of plant roots or animal burrows, it is important to realize that burrow and root density are not continuous from the soil surface to the maximum reported depths; biotic activity decreases with depth. The depths to which insects, animals (burrows), and plants (roots) are likely to occur define the biologically active zone. The working hypothesis for purposes of this screening ecological risk assessment is that biological activity at the 200-PW-1, 3 and 6 OUs is limited largely to the top 2.44 to 3.05 m (8 to 10 ft), and a conceptual model of belowground biotic activity is presented in Figure B-1.

Empirical data on arid-adapted species offer support for the conceptual model, showing the burrow fraction and percentage of root biomass is heavily weighted to shallow soils (Figure B-2). "Biotic Transport of Radionuclides From A Low-Level Radioactive Waste Site" (Kennedy et al., 1985), and "Vertical Distribution of Soil Removed by Four Species of Burrowing Rodents in Disturbed and Undisturbed Soils" (Reynolds and Laundré, 1988) offer data for pocket mice, kangaroo rats, pocket gophers, and ground squirrels to illustrate how burrow density is a function of depth. Except for the kangaroo rat, these arid-adapted mammals are all Hanford Site species (PNNL, 2008, *Hanford Site Ecological Monitoring & Compliance*). Similar to mammalian burrow density, the belowground mass of deeply rooting desert shrubs also is weighted toward greater density near the surface and, similar to mammalian burrow density, root mass declines with depth (Figure B-2). In Figure B-2, the different colors represent data on different species of plants and animals. The y-axis represents depth, and the x-axis is the fraction of burrow density or plant-root density above a given depth in the subsurface. For example, approximately 80 percent of the plant-root density is located above a depth of 30 cm (12 in.). Thus, while certain plants and animals have maximum rooting or burrowing depths many feet into the subsurface, it is clear most of the biotic activity for these species is in the top few feet of the soil column. The animal and plant data used to generate Figure B-2 have been published previously in WMP-20570, Appendix F.

Soil macroinvertebrates also burrow extensively in deserts. For example, some species of spiders (e.g., trap-door spiders) are known to burrow albeit shallowly (usually less than 15 cm [6 in.]), as do many species of arid-system beetles such as the ubiquitous *Eleodes* spp. and other darkling beetles. At the Hanford Site, harvester ants likely are the deepest burrowing animals occurring on the Central Plateau (PNL-2774). For this reason, harvester ants are actively managed for removal where they occur on waste sites. For example, alpha contamination was found on the soil surface at one of the sites (216-Z-9 Trench) that apparently had been brought to the surface by ants. The contamination was detected at the edge of the existing concrete pad through site surveillance. This contamination pathway was promptly mitigated by pesticide application and the installation of a biobarrier to circumvent this potential exposure pathway. These management practices serve to break potential exposure pathways created through biointrusion under current conditions at the Hanford Site. However, for the purposes of making a baseline assessment of ecological risks, it is necessary to take into consideration that biointrusion by harvester ants could potentially create exposure pathways. The potential exposure pathways that could exist include:

- Potential accumulation of radionuclides and inorganics by ants burrowing into contaminated soils (up to a depth of 8.8 feet, based on the data presented in Table B-1).
- Potential exposures to insectivorous or omnivorous birds and mammals from ingestion of ants that have accumulated radionuclides and inorganic contaminants.
- Potential exposures of wildlife from ingestion of radionuclides and inorganics in contaminated soil that has been exhumed and brought to the surface by ants.
- Potential accumulation by plants of contaminants in exhumed soils that are subsequently incorporated into surface soil through wind action and rainfall.

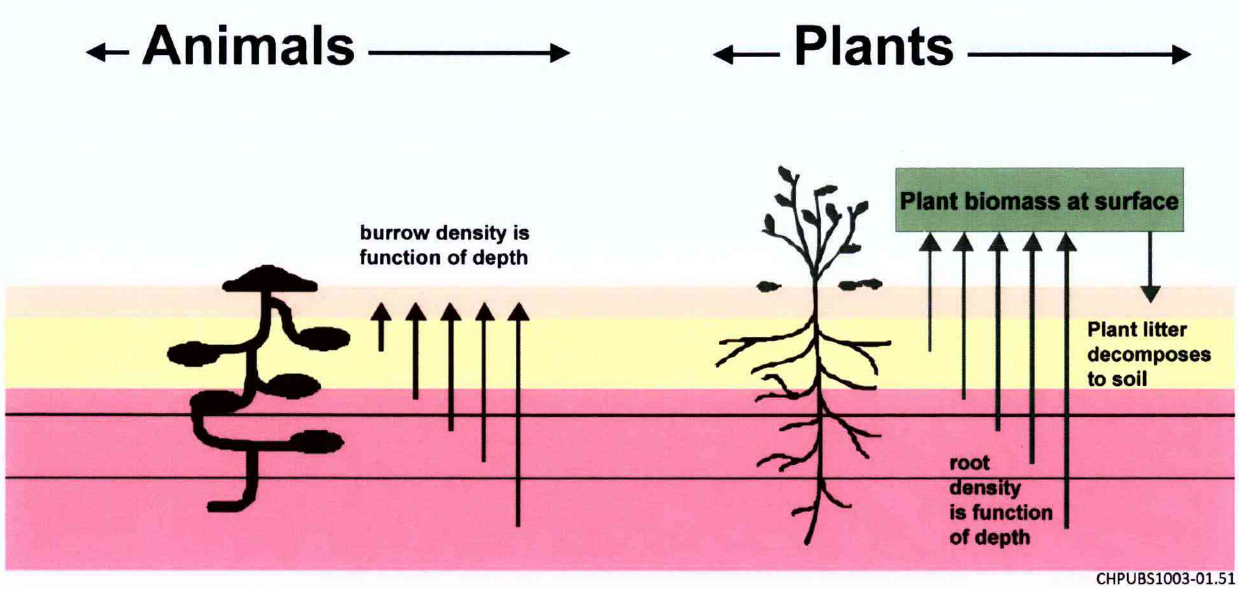
Plants rely on extensive belowground biomass to capture nutrients and water. The extent of the rooting systems for species in the 200 Areas was evaluated in PNL-5247, *Rooting Depth and Distributions of Deep-Rooted Plants in the 200 Area Control Zone of the Hanford Site*. This study concentrated on plant species suspected of having deep-root systems and those species reported in previous studies to contain radionuclides in aboveground parts. These maximum rooting depths listed in Table B-1 are consistent with the majority of plant species in a literature review of rooting depth by vegetation types ("Maximum Rooting Depth of Vegetation Types at the Global Scale" [Canadell et al., 1996]). This review indicates 194 of 253 species had maximum rooting depths of 2 m (6.6 ft) or less. Although root depth determines whether buried waste is accessible by plants, biologically mediated contaminant transport is a function of the biomass available for transport. Consequently, the relative density of roots is more important than the absolute depth attained. As shown in Figure B-2, only a minor percentage of roots ever reach depths greater than 1.5 m (5 ft) bgs. This is especially true for arid-adapted plants of the Central Plateau. In dry environments such as this where groundwater is inaccessible, plants must rely on meteoric water infiltration to survive, and plant roots tend to extend laterally (rather than vertically) to capture this infiltrating water.

It is important to recognize that biointrusion into subsurface sites requires aboveground conditions favoring burrowing animals and deep-rooted plants. These conditions are lacking for the majority of sites within the 200-PW-1, 200-PW-3, and 200-PW-6 OUs under current conditions because of the institutional controls in place to discourage biotic access to buried waste. These controls include: (1) at least an annual visual site inspection to look for evidence of subsidence or animal intrusion, (2) a surface radiological survey performed in any areas where radiation is detected, covered with soil, or posted for further action, (3) herbicide application performed several times a year to control any vegetation, and (4) pesticides applied as needed to control ants and termites.

Because of the active management practices and lack of biological activity at the 2.44 to 3.05 m (8 - 10 ft) bgs interval, exposure potential to ecological receptors is not of concern under current conditions for the remaining sites, because waste is buried deeper, and there are no aboveground receptors that could access the waste. These waste sites not of concern under current conditions include the following:

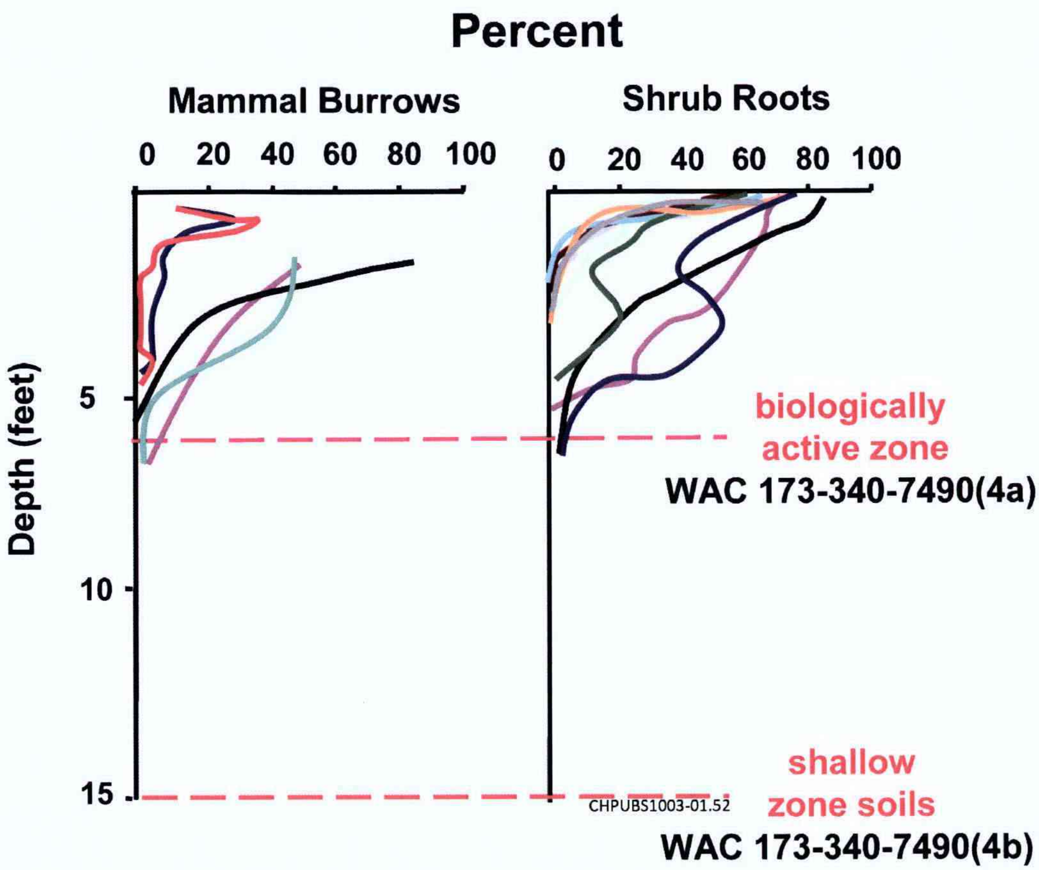
- 216-A-7 Crib
- 216-A-8 Crib
- 216-A-24 Crib
- 216-Z-1 Crib
- 216-Z-2 Crib
- 216-Z-1A Tile Field

However, as discussed below in Section B2.0, conditions at 200-PW-1, 200-PW-3, and 200-PW-6 OU waste sites might provide ecological exposure pathways under future conditions, which may require further evaluation as part of the alternatives evaluation. Factors that preclude potential ecological exposure pathways and risk under current conditions include: physical barriers preventing exposure, lack of habitat to support receptors capable of waste biointrusion, and an active management program to preclude the establishment of deeply rooted plants and animal burrowing. However, is it uncertain that wastes are buried deeper than plants and animals can access at all of these sites. While many of the site currently do not support habitat, these conditions might not be present in the future. Finally, active management currently precludes biointrusion of plants and animals. Should the program of active management cease, the possibility exists that deeply rooted plants and animal burrowing could be re-established on these sites in the future, creating exposure pathways from buried contaminants in soil. Table B-2 identifies the key characteristics of each of the 17 waste sites in the 200-PW-1, 200-PW-3, and 200-PW-6 OUs. Section B2.0 of this appendix discusses these factors for each of the sites based on data reported in WIDS. Section B3.0 presents a screening-level ecological risk characterization for the 200-PW-1, 200-PW-3, and 200-PW-6 OU waste sites.



(Source: WMP-20570)

Figure B-1. Conceptual Model of Biotic Activity in Soil



Note: Colored lines represent data on mammal burrow density for pocket gophers, pocket mice, kangaroo rats, and Townsend's ground squirrel. Plant-root density is represented by white bursage, annual bursage, basin big sagebrush, four-winged saltbush, shadescale saltbush, blackbrush, Nevada jointfir, rubber rabbitbrush, range ratany, creosote bush, Anderson's wolfberry, and rabbit thorn.

(Source: WMP-20570)

Figure B-2. Fraction of Burrow and Root Density Versus Depth Below the Ground Surface

B2.0 200-PW-1/3/6 Operable Units Ecological Risk Assessment Site Summaries

This section provides a brief description of each site in the 200-PW-1, 200-PW-3, and 200-PW-6 OU outlined in Table B-2. The site summaries are based on information in WIDS, including information on site regulation/management, current site configuration, original dimensions of the sites, process history, and relevant environmental monitoring, release, and cleanup information.

B2.1 216-Z-1 and 216-Z-2 Cribs

The 216-Z-1 and 216-Z-2 Cribs consist of two wooden timber boxes connected by a central pipe which appears to have discharged waste at the tops of the boxes (see Figure 2-7 in the FS report). The 216-Z-2 Crib overflowed into the 216-Z-1 Crib, which overflowed into the 216-Z-1A Tile Field. Each unit is set and backfilled in a deep, square excavation. Two risers are visible from the surface of each crib.

The bottom dimensions of each crib are 3.7 m (12 ft) long by 3.7 m (12 ft) wide by 4.3 m (14 ft) deep with 2.1 m (7 ft) overburden depth. These cribs were designed to dispose of aqueous and organic wastes in the soil column. The unit received waste from the 234-5Z, the 236-Z, and the 242-Z Buildings.

Table B-2. Summary of Characteristics for the 200-PW-1/3/6 Operable Unit Waste Sites as Indicators of Exposure Potential for Ecological Receptors

Operable Unit	Site	Physical Barrier Currently Present? (Yes/No)	Overburden, m (ft)	Cover Thickness, m (ft) (see note)	Aboveground Habitat Currently Present? (Yes/No)
200-PW-1	216-Z-1 and 216-Z-2 Cribs	No	2.1 (7)	4.3 (14)	Yes
200-PW-1	216-Z-12 Crib	No	4.3 (14)	5.8 (19)	No
200-PW-1	216-Z-18 Crib	No	4.9 (16)	5.5 (18)	No
200-PW-1	216-Z-1A Tile Field	No	3.0 (10)	4.6 (15)	Yes
200-PW-1	216-Z-3 Crib	No	2.4 (8)	5.2 (17)	Yes
200-PW-1	216-Z-9 Trench	No	None	6.4 (21)	No
200-PW-1	241-Z-361 Settling Tank	Yes	None	5.5 (18)	Yes
200-PW-3	216-A-24 Crib	No	3.0 (10)	4.6 (15)	Yes
200-PW-3	216-A-31 Crib	No	None	7.3 (24)	No
200-PW-3	216-A-7 Crib	No	None	4.9 (16)	No
200-PW-3	216-A-8 Crib	No	None	4.3 (14)	Yes
200-PW-3	UPR-200-E-56	No	0.6 (2)	4.6 (15)	Yes
200-PW-6	216-Z-10 Injection/ Reverse Well	No	None	45.7 (150)	No
200-PW-6	216-Z-5 Crib	No	4.3 (14)	5.5 (18)	No
200-PW-6	216-Z-8 French Drain	No	None	4.6 (15)	No
200-PW-6	241-Z-8 Settling Tank	Yes	1.8 (6)	1.8 (6)	No

Notes:

Cover thickness measured to the bottom of the waste site. Contaminants might be present at shallower depths (< 10-15 ft) in waste site soils, potentially representing ecological exposure pathways.

Liquid wastes discharged to these cribs would percolate into the soil, forming a layer of contamination at the bottom, 6.4 m (21 ft) bgs. However, it is not known if the wooden boxes leaked, potentially contaminating soils around the boxes at shallower depths and creating ecological exposure pathways.

Surface radiological surveys are performed routinely. In 1981, several characterization and monitoring wells were placed around the 216-Z-1 and 216-Z-2 Cribs. The maximum depth of the plutonium and americium contamination was found approximately 30 m (99 ft) below the bottom of the waste site. From 1991 to 2005, soil-vapor extraction operations removed 24,528 kg (54,075 lb) of carbon tetrachloride from the 216-Z-1A/Z-18 Well Field. Monitoring results suggest the presence of radionuclides in the near-surface and deeper soils.

B2.1.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, rabbitbrush.

Cover Thickness: The site is covered with 2.1 m (7 ft) of backfill (overburden) for a total of 4.3 m (14 ft) of backfill.

Physical Barrier: None.

B2.2 216-Z-12 Crib

The site is an inactive, belowgrade waste management unit. The site consists of a deep rectangular excavation with a vitrified, perforated, clay pipe running the length of the crib. A second 6-in.-diameter steel pipe (bypass pipeline) was installed in 1968 and runs the length of the crib to the west of the original pipe. The bottom 1.5 m (5 ft) of the excavation was backfilled with gravel and covered with a polyethylene barrier. The remaining excavation was backfilled to grade. It is marked and posted with Underground Radioactive Material signs.

The bottom dimensions of the crib are 91.4 m (300 ft) long by 6.1 m (20 ft) wide by 5.8 m (19 ft) deep with 4.3 m (14-ft) overburden depth. The crib received Plutonium Finishing Plant liquid process waste and laboratory waste from the 234-5Z Building via the 241-Z-361 Settling Tank. According to process history information (see Figure 2-6 in the FS report), waste entered the crib through a perforated vitrified clay pipe at a depth 4.6 m (15 ft) bgs. While there is overburden (reportedly to a depth of 18 feet) which presumably limits ecological exposure pathways, it is not known if ponding of effluent resulted in residual contamination of soils on the walls of the crib at depths shallower than 10 to 15 ft (considered as depths below which ecological exposure pathways are unlikely to be present).

The crib was partially vitrified as part of an in situ vitrification test project that resulted in a 408 metric ton (450-ton) block of vitrified soil, extending to a depth of 7.3 m (24 ft). The test demonstrated that transuranic contaminants and 26,000 ppm of fluorides were retained in the vitrified product. The crib was downposted to underground radioactive material. Fifteen soil sample locations were used to determine that the surface of the crib was free of contamination. The vent risers were sealed as a preventive measure for potential passive radioactive emissions.

A surface radiological survey is performed annually. The highest concentration of plutonium was located in the sediment immediately below the bottom of the crib. No plutonium level greater than 1 pCi/g was detected from 12 to 30 m (40 to 98 ft) below the crib bottom. Low levels of plutonium and americium were detected 36 m (118 ft) below the crib bottom, which was the maximum depth analyzed.

B2.2.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 4.3 m (14 ft) of backfill (overburden) for a total of 5.8 m (19 ft) of backfill to the floor of the crib.

Physical Barrier: None.

B2.3 216-Z-18 Crib

The 216-Z-18 Crib is a belowgrade inactive management unit. The crib consists of five parallel, north-south running trenches bisected by a steel distribution pipe. Near the center of each trench, two perforated, fiberglass-reinforced epoxy pipes exit each side of the distribution line. The distribution and trench piping lie on a 0.3 m (1-ft) thick bed of gravel. The pipes were buried under an additional 0.3 m (1 ft) of gravel, a membrane, and sand cover. The trenches then were backfilled to grade. The site is marked and posted with Underground Radioactive Material signs.

The bottom dimensions of the crib are 63.1 m (207 ft) long by 3.05 m (10 ft) wide by 5.5 m (18 ft) deep with 4.9 m (16 ft) overburden depth. This unit received wastes from the 241-Z-361 Settling Tank. The crib disposed of solvent and acidic aqueous waste from the Plutonium Reclamation Facility in the 236-Z Building.

The most significant release path for this site is to groundwater. In 1981, several characterization and monitoring wells were placed around the 216-Z-18 Crib. The maximum depth of the plutonium and americium contamination was found approximately 30 m (99 ft) below the bottom of the waste site. From 1991 to 2005, soil-vapor extraction operations removed 24,528 kg (54,075 lb) of carbon tetrachloride from the 216-Z-1A/216-Z-18 Well Field.

B2.3.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 4.9 m (16 ft) of backfill (overburden) for a total of 5.5 m (18 ft) of backfill to the bottom of the waste site.

Physical Barrier: None.

B2.4 216-Z-1A Tile Field

The tile field is located inside a chain-link fence that is radiologically posted. It is a belowgrade trunk line oriented north to south with seven pairs of lateral pipes spaced in a herringbone pattern. The vitrified clay pipe lies on a gravel bed. The length of the tile field was expanded twice. The original section is known as 216-Z-1AA. The expanded sections are known as 216-Z-1AB and 216-Z-1AC. The excavation was backfilled to grade.

The total length of the tile field, including all three extensions, is 79.3 m (260 ft) by 4.6 m (15 ft) deep with 3.0 m (10 ft) overburden depth. The bottom dimensions of 216-Z-1AA are 22.9 m (75 ft) long by 30.5 m (100 ft) wide. The bottom dimensions of 216-Z-1AB are 30.5 m (100 ft) long by 30.5 m (100 ft) wide, and the bottom dimensions of 216-Z-1AC are 25.9 m (85 ft) long by 30.5 m (100 ft) wide. The site received waste from the 234-5Z, 236-Z, and 242-Z facility operations at the Z Plant. The tile field was originally constructed to receive liquid waste overflow from the 216-Z-1 and the 216-Z-2 Cribs. Later the cribs were bypassed and the waste was routed directly into the tile field.

According to the process history (Figure 2-4 in the FS report), discharge piping to the tile field were originally placed on a gravel bed 4.3 m (14 ft) bgs. Process history descriptions also include mention of the tile field receiving overflows from other units. While there is overburden (reportedly to a depth of 15 feet) which presumably limits ecological exposure pathways, it is not known if ponding of effluent resulted in residual contamination of soils on the walls or portions of the floor of the tile field at depths shallower than 10 to15 ft (considered as depths below which ecological exposure pathways are unlikely to be present).

Surface radiological surveys are performed on a routine basis. Characterization efforts identified radionuclide contamination and high concentrations of carbon tetrachloride below the waste site structures. In 1981, several characterization and monitoring wells were placed around the 216-Z-1A Tile Field. The maximum depth of the plutonium and americium contamination was approximately 30 m (99 ft) below the bottom of the waste site. Soil-vapor extraction operations were begun in 1992 to extract carbon tetrachloride from the vadose zone beneath the 216-Z-1A Tile Field.

B2.4.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, rabbitbrush.

Cover Thickness: The site is covered with 3.0 m (10 ft) of backfill (overburden) for a total of 4.6 m (15 ft) of backfill to the bottom of the site.

Physical Barrier: None.

B2.5 216-Z-3 Crib

The 216-Z-3 Crib was constructed of three 1.2-m (4-ft) long, perforated corrugated metal culverts laid horizontally, end to end, on gravel-filled excavation. Wire screens were welded on the ends of the pipes to prevent gravel from intruding into the pipe, with 2.5 cm (1-in.) holes drilled every 15 cm (6 in.) around the circumference of the pipe at 30 cm (1-ft) intervals. The culvert rests on a 5.2-m (17-ft) bed of gravel, 2.4 m (8 ft) below grade. Two layers of asphalt roofing paper were laid over the crib construction and the site was backfilled to grade.

The dimensions of the crib are 20.1 m (66 ft) long by 8.4 m (28 ft) wide by 5.2 m (17 ft) deep with 2.4 m (8-ft) overburden depth. The diameter of the associated culvert style distribution drain pipe is 0.9 m (3 ft).

Environmental monitoring for this crib includes several local monitoring wells and regular radiological surveys. In 1959, groundwater samples indicated alpha contamination in the groundwater below the 216-Z-3 Crib. Soil-vapor extraction operations began in 1992 to extract carbon tetrachloride from the vadose zone beneath the 216-Z-1A Tile Field.

B2.5.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, rabbitbrush.

Cover Thickness: The site is covered with 2.4 m (8 ft) of backfill (overburden) for a total of 5.2 m (17 ft) of backfill to the bottom of the waste site.

Physical Barrier: None.

B2.6 216-Z-9 Trench

The 216-Z-9 Trench is marked and posted with Underground Radioactive Material signs. In 1999, a gravel bio-barrier, measuring 6.1 m (20 ft) by 4.0 m (13 ft), was placed over an area of surface contamination. This area also is posted as underground radioactive material. The 216-Z-9 Trench is an inactive, belowgrade waste management unit. It is a rectangular structure, with a concrete cover supported by six concrete columns. The trench walls and support columns are covered in an acid-resistant brick. Two stainless steel pipes discharge effluent above the trench bottom.

The dimensions of the trench are 36.6 m (120 ft) long by 27.4 m (90 ft) wide by 6.4 m (21 ft) deep. The 216-Z-9 waste site is an enclosed trench that received solvent and aqueous wastes from the Z Plant Recovery of Uranium and Plutonium by Extraction (RECUPLEX) process. The 216-Z-9 Trench was the only waste site used for solvent disposal during the RECUPLEX operation. Solvents used in the process included carbon tetrachloride, dibutyl phosphate, and dibutyl butyl phosphonate.

According to the process history, two stainless steel pipes discharged effluent above the trench bottom (21 ft, see Figure 2-3 in the FS report). The discharged effluent volume reportedly was greater than the soil pore volume (see Section 2.4.1.1 in the FS report), but it is not known if the ponded effluent resulted in residual contamination of soils on the walls of the trench, above the trench bottom. Therefore the possibility exists of contaminants being present at depths in soil shallower than 15 feet (considered as a depth below which ecological exposure pathways are unlikely to be present).

A surface radiological survey is performed routinely at this site. In 1981, several characterization and monitoring wells were placed around the 216-Z-9 Trench. The maximum depth of the plutonium and americium contamination was approximately 30 m (99 ft) below the bottom of the waste site. From 1991 to 2005, soil-vapor extraction operations removed 54,183 kg (119,453 lb) of carbon tetrachloride from the 216-Z-9 Well Field. Groundwater Wells 299-W15-8, 299-W15-9, 299-W15-82, 299-W15-84, 299-W15-85, 299-W15-86, and 299-W15-95 monitor this unit. Scintillation probe profiles indicate that breakthrough to the groundwater of radionuclides has not occurred (1983). Four 1-in.-diameter core samples were collected from the bottom of the crib in 1959 to determine the amount of plutonium in the soil. The samples were collected through two risers and two vent stacks that extended through the concrete crib cover. Additional core samples of the soil were collected to a depth of 2.4 m (8 ft) in 1973 to characterize the crib contaminants.

B2.6.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Physical Barrier: None.

Cover Thickness: The site is covered with a total of 6.4 m (21 ft) of backfill (from surface to the trench bottom).

Active Management: This is site is managed by Fluor Hanford/Plutonium Finishing Plant to include, at a minimum, annual monitoring and herbicide and pesticide application as needed.

B2.7 241-Z-361 Settling Tank

The unit is an underground reinforced-concrete structure with a 0.95-cm (3/8-in.) steel liner. The tank has inside dimensions of 7.9 by 4.0 m (26 by 13 ft) with 0.3 m (1-ft) -thick walls. The bottom slopes, resulting in an internal height variation between 5.2 and 5.5 m (17 and 18 ft). The top is 0.6 m (2 ft) below grade. A 15 cm (6-in.) stainless steel inlet pipe from the 241-Z Tank Pit (WIDS Site Code 241-Z) enters the tank from the north, approximately 4-5 ft from the top of the tank. A single 20 cm (8-in.) stainless steel pipe exits the tank from the south, at the same elevation as the pipe entering the tank (see Figure 2-9 in the FS report). Two manhole covers and frames and several risers are visible above grade.

Process history information, the settling tank is an underground reinforced concrete structure. Evidence shows the tank likely did not leak (see Figure 2-9 in the FS report). Potential ecological exposure pathways likely are not present at this waste site.

The outside dimensions of the settling tank are 8.5 m (28 ft) long by 4.6 m (15 ft) wide by 5.5 m (18 ft) deep. The tank served as a settling tank for liquid waste from the 234-5Z, 242-Z, and 236-Z Buildings. The waste streams were routed through the 241-Z Sump Tanks for neutralization and then to the 241-Z-361 Settling Tank to settle out any solids. After passing through the settling tank, the waste was routed to the 216-Z-1, 216-Z-2, 216-Z-3, 216-Z-12, and 216-Z-18 Cribs and the 216-Z-1A Tile Field.

DOE/RL-88-30, *Hanford Site Waste Management Units Report*, states that prioritization of this facility for decommissioning classifies the relative radiological hazard as high in comparison with other 200 Area surplus facilities. Detailed sample results are documented in HNF-8735, *241-Z-361 Tank Characterization Report*. Routine radiation surveys, airborne radionuclide monitoring, and visual inspections are performed.

B2.7.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, rabbitbrush.

Cover Thickness: The site is covered with a total of 5.5 m (18 ft) of backfill.

Physical Barrier: Yes.

Active Management: The following tasks are part of the active management of the 241-Z-361 Settling Tank: routine surveillance and housekeeping; any necessary testing or replacement of the high-efficiency particulate air filter on the tank breather vent; and structural evaluation of the tank every 5 years in accordance with the safety requirements.

B2.8 216-A-24 Crib

The 216-A-24 Crib is surrounded with concrete AC-540 markers and posted with Underground Radioactive Material signs. The crib was built with four sections, each 107 m (350 ft) long, separated by soil berms. The sections were installed at increasingly lower elevations to allow the effluent to cascade from one section to the next. The crib was constructed with a 38-cm (15-in.)-diameter (perforated bottom half), galvanized, corrugated pipe, placed horizontally 3 m (10 ft) below grade. The crib excavation has 46,750 m^3 ($1.65 \times 10^{+05}$ ft^3) of gravel fill and is backfilled. A polyethylene barrier is located between the gravel and the backfill. The side slope is 1.5:1. Eight 20-cm (8-in.)-diameter wells on concrete pads are located on this crib. The wells extend from the bottom of the crib to 0.9 m (3 ft) above grade. Four 38 cm (15-in.) corrugated risers extend from the distributor pipe to grade with filter box assemblies on top of the risers.

The bottom dimensions of the crib are 426.7 m (1,400 ft) long by 6.1 m (20 ft) wide by 4.6 m (15 ft) deep with 3.0 m (10-ft) overburden depth. The crib was built to receive condensate waste from the 241-A, 241-AX, 241-AY, and 241-AZ Tank Farms. The installation of surface condensers greatly reduced the volume of liquid being discharged to the cribs.

Data from 1977 indicate that a breakthrough to the groundwater could have occurred from the first and second sections of the crib. Characterization information collected in 1979 included analysis of plants and animals and three backhoe excavations. None of the excavations found contamination in the overburden soils. The subsurface gravel layers did have considerable levels of contamination, as well as some rabbitbrush and mice, suggesting that potential ecological exposure pathways related to biointrusion could exist. Cesium-137 was the most prevalent contaminant. A routine surface radiological survey is performed annually.

B2.8.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, bunchgrasses

Cover Thickness: The site is covered with 3.0 m (10 ft) of backfill (overburden) for a total of 4.6 m (15 ft) of backfill to the bottom of the crib.

Physical Barrier: None.

B2.9 216-A-31 Crib

The 216-A-31 Crib is located inside a large Underground Radioactive Material area that has a WIDS Site Code of 200-E-103. The crib is marked with cement posts on four corners.

The bottom dimensions of the crib are 21.3 m (70 ft) long by 3.0 m (10 ft) wide by 7.3 m (24 ft) deep. The crib received effluent from the 202-A "L-Cell" via the 241-A-151 Diversion Box. The L-Cell was the location of the final plutonium concentration step in the plutonium-uranium extraction process. The site was deactivated in 1966 by blanking the L-Cell nozzles to the 241-A-151 Diversion Box, which routed effluents to the unit. The unit consists of a 21.3-m by 3.0-m by 7.3-m (70-ft by 10-ft by 24-ft) deep excavation that includes a 7.6-cm (3-in.) Schedule 10 stainless steel perforated distribution pipe placed horizontally 6.4 m (21 ft) below grade. The excavation has 1.8 m (6 ft) of gravel fill and has been backfilled. The side slope is 1:1.5.

While there is overburden (reportedly to a depth of more than 15 feet) which presumably limits ecological exposure pathways, it is not known if ponding of effluent resulted in residual contamination of soils on the walls of the crib at depths shallower than 10 to15 ft (considered as depths and below which ecological exposure pathways are unlikely to be present).

B2.9.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 7.3 m (24 ft) of backfill to the bottom of the crib.

Physical Barrier: None.

B2.10 216-A-7 Crib

The crib is marked and posted with Underground Radioactive Material signs. Both the 216-A-7 and 216-A-1 Cribs are inside this Underground Radioactive Material area.

The bottom dimensions of the crib are 3.0 m (10 ft) long by 3.0 m (10 ft) wide by 4.9 m (16 ft) deep. The crib began receiving catch tank and sump waste from the 241-A-152 Diversion Box in January 1956. The effluent pipeline between the 241-A-152 Diversion Box sump and the crib was blanked off in July 1959. The sump waste was re-routed to the catch tank. From July 1959 through November 1966, the crib received tributyl phosphate from the Plutonium-Uranium Extraction Plant and pump pit/catch tank drainage from the 241-A-152 Diversion Box. A 15 cm (6-in.) perforated vitrified clay pipe is placed horizontally 3.0 m (10 ft) below grade. A 3.0 m (10 ft) length of 15-cm (6-in.) perforated vitrified clay pipe is perpendicular to the first pipe, forming a cross pattern. It is 4.9 m (16 ft) deep and is filled with approximately 2.1 m (7 ft) of coarse rock with a volume of 99 m^3 (3,500 ft^3). The site has been backfilled. The side slope from the surface to 3.0 m (10 ft) is 1:1 and from 3.0 m (10 ft) to the bottom is 2:1.

A surface radiation survey is performed annually. The site is monitored by Well 299-E25-54. Scintillation probe profiles identified contamination between 3.9 m (13 ft) and 9.1 m (30 ft) below the surface. No contamination was identified from 9.1 m (30 ft) to 41.8 m (137 ft). While there is overburden (reportedly to a depth of more than 15 feet) which presumably limits ecological exposure pathways, it is not known if ponding of effluent resulted in residual contamination of soils on the walls of the crib at depths shallower than 10 to15 ft (considered as depths below which ecological exposure pathways are unlikely to be present).

B2.10.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 4.9 m (16 ft) of backfill to the crib bottom.

Physical Barrier: None.

B2.11 216-A-8 Crib

The 216-A-8 Crib and overflow area are surrounded by chain and concrete AC-540 markers. The crib and overflow area are posted with Underground Radioactive Material signs. Crib overflow was accomplished through a 40.6 cm (16-in.) -diameter pipe exiting to the north at the east end of the crib. The pipe emptied into a narrow ditch that flowed northward. A small overflow pond was excavated at the northeast end of the ditch to receive the excess wastewater from the crib.

A 61 cm (24-in.) -diameter, Schedule 20, perforated distribution pipe is located 2.6 to 3.5 m (8.5 to 11 ft) below grade along the length of the crib. The site contains approximately 5,830 m^3 (206,000 ft^3) of gravel fill. The crib excavation side slope is 1:2. Four test risers extended above grade. Two layers of Sisalkraft[1] paper separate the gravel fill from the backfill. The 216-A-508 Control Structure is located west of the crib.

The bottom dimensions of the crib are 259.1 m (850 ft) long by 6.1 m (20 ft) wide by 4.3 m (14 ft) deep. The crib was originally constructed in 1955 to receive condensate and cooling water discharge from the 241-A and 241-AX Tank Farms. In May 1958, it was determined the crib had reached its radionuclide capacity. The effluent was routed to the 216-A-24 Crib via the 216-A-508 Control Structure, and the

[1] Sisalkraft (paper) is a trademark of Fortifiber Corporation, Los Angeles, California.

cooling water was routed to the 216-A-25 Pond. However, the 216-A-8 Crib was intermittently reactivated over the years (from 1966 until 1983) to receive additional tank farm condensate effluent.

Based on the depth of discharge to this crib and possible contamination of side-walls through ponding of wastes, the possibility exists of contaminants being present at depths in soil shallower than 10 to 15 feet (considered as a depth below which ecological exposure pathways are unlikely to be present).

Radiological surveys are performed annually and have previously identified potential ecological exposure pathways through plant biointrusion. In 1979, a large, growing rabbitbrush plant was found to be contaminated with a radiation level of 6,000 counts per minute. The open risers were contaminated with radiological readings ranging from 600 to 6,000 counts per minute. In 1985, the vent filter on the 216-A-508 Control Structure had a direct reading of 10,000 counts per minute. Several rabbitbrush plants were found to be contaminated with a maximum reading of 35,000 counts per minute. In 1988, vegetation growing on the crib had radiological readings of 500 to 20,000 counts per minute, and soil by the crib had radiological readings of 400 to 70,000 counts per minute.

B2.11.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, bunchgrasses.

Cover Thickness: The site is covered with 4.3 m (14 ft) of backfill.

Physical Barrier: None.

B2.12 UPR-200-E-56

The unplanned release (UPR) site, UPR-200-E-56, is a surface-stabilized area located north of the west end of the 216-A-24 Crib. The site is posted and marked as an Underground Radioactive Material area.

The dimensions of the site are 30.5 m (100 ft) long by 30.5 m (100 ft) wide.

On June 13, 1979, Radiation Monitoring was informed that moisture was observed in the excavation east of the 200 East Area perimeter fence where fill soil was being obtained for the construction of the 241-AN Tank Farm. The construction contractor backfilling around the new tanks in the 241-AN Tank Farm had mistakenly selected a borrow area adjacent to the 216-A-24 Crib instead of the designated area, which was farther north. Radiological surveys revealed beta contamination up to 8,000 counts per minute in the moist excavation, on the earthmoving equipment, and in the newly hauled-in soil around the new 241-AN Tanks. The source of the contamination was determined to be moisture from the 216-A-24 Crib that had migrated laterally over the surface of a 10.2-cm (4-in.) crust of hardpan. The hardpan was approximately 4.6 m (15 ft) below normal ground surface. The excavation was dug sloping from 1.5 to 6.1 m (5 to 20 ft) deep, 131.1 m (430 ft) long, and an average of 33.5 m (110 ft) wide. The size of the excavation was approximately 0.4 hectare (1 acre).

In 1979, several hundred yards of contaminated soil were taken out of the 241-AN Tank Farm and returned to the excavation north of the 216-A-24 Crib. However, the volume of material was insufficient to fill the excavation area. It was decided to take contaminated soil and vegetation from nearby perimeter fences and the northeast fence line of the 241-C Tank Farm and place it into the excavation to help fill the excavation area. An additional 15- to 20-cm (6- to 8-in.) layer of clean soil was placed over the excavation and the site was reposted to Underground Radioactive Material.

The area north of the 216-A-24 Crib, known as the 216-A-24 Excavation Site, was used again in 1985 to dispose of contaminated soil from the 244-A Lift Station area (UPR-200-E-100). After the contaminated soil from the 244-A Lift Station was placed into the "crib excavation," the 216-A-24 Crib Excavation was stabilized with 0.6 m (2 ft) of clean dirt and vegetated with wheatgrass.

As described previously using process history information (see Figure 2-14 from the FS report), portions of the UPR were excavated to a minimum depth of 5 ft bgs. If there is no consideration given to the cover, then contaminants may be soil at portions of this site at depths accessible to deep rooted plants and burrowing animals (see Table 2-16 from the FS report for contaminants detected at these shallower depths in soil).

B2.12.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: Moderate vegetation, bunchgrasses.

Cover Thickness: The site is covered with 4.6 m (15 ft) of backfill with an overburden of 0.6 m (2 ft).

Physical Barrier: None.

B2.13 216-Z-10 Injection/Reverse Well

This site is a reverse well extending approximately 0.3 m (1 ft) above grade. The aboveground portion of the well end is capped with a flange. The well casing is constructed of steel pipe. The site was interim stabilized in 1990.

The dimensions of the 216-Z-10 Injection/Reverse Well are 45.7 m (150 ft) deep with a diameter of 0.15 m (0.50 ft). The well received process and laboratory waste from the 231-Z Building via the 231-Z-151 Sump between February and June 1945.

Potential for a release to groundwater is high because of the large volume of waste disposed of at the site. Three wells were drilled near this site in 1947. None of the soil samples from the wells showed any contamination.

B2.13.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered by 45.7 m (150 ft) of backfill.

Physical Barrier: None.

B2.14 216-Z-5 Crib

The 216-Z-5 Crib is an inactive waste management unit located below grade. The crib is oriented in a north-south configuration with a transfer pipe connecting to two wooden sump boxes. Each box was placed at the bottom of a rectangular excavation. The two excavations were then backfilled to grade.

The dimensions for a single crib are 4.3 m (14 ft) long by 4.3 m (14 ft) wide by 5.5 m (18 ft) deep with an overburden of 4.3 m (14 ft). This crib received 231-Z Building plutonium-contaminated process waste via the 231-W-151 Vault. The liquid process waste was discharged to the soil column via the crib. More than 26 million liters (7 million gal) of waste containing approximately 3,000 g (7 lb) of plutonium were discharged to the cribs.

Liquid wastes discharged to this crib would percolate into the soil, forming a layer of contamination at the bottom, 5.5 m (18 ft) bgs. However, it is not known if the wooden boxes leaked, potentially contaminating soils around the boxes at shallower depths and creating ecological exposure pathways. In addition, leaks from the shallow transfer line to the cribs could have release contaminants to soils accessible to ecological receptors.

The cribs were surface stabilized in 1990. This site receives routine radiological surface surveys and well monitoring.

B2.14.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 4.3 m (14 ft) of backfill (overburden) for a total of 5.5 m (18 ft) of backfill.

Physical Barrier: None.

B2.15 216-Z-8 French Drain

The 216-Z-8 French drain is constructed of two sections of 0.9-m (3-ft) -high standard clay tile culverts, stacked vertically underground. The culverts are filled with gravel and rest on a 1.5 m (5-ft) -diameter by 0.9 m (3-ft) -deep bed of gravel with a slope of 2.5:1. There is a 10 cm (4-in.) -thick concrete top 2.4 m (8 ft) below grade. The bottom of the French drain is 5.5 m (18 ft) below grade.

The dimensions of the French drain are 4.6 m (15 ft) with a diameter of 0.9 m (3 ft). The silica storage tank supernate overflowed into the French drain from 1955 to 1962. Approximately 9,590 L (2,530 gal) of neutral-basic waste overflowed from the tank during that time.

Process history information (see Figure 2-15 from the FS report) indicates that the pipe from the 241-Z-8 Settling Tank entered the 216-Z-8 French Drain at a depth of 2.44 m (8 ft) bgs. This pipe appears to have discharged contaminants into gravel contained within a clay tile culvert. It is not known if there have been leaks from the culvert. Such leaks could result in lateral migration of contaminants in soil at depths accessible by ecological receptors. Intrusion into the French drain by deeply-rooted plants or burrowing animals is unlikely to occur.

B2.15.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 4.6 m (15 ft) of backfill to the bottom of the waste site.

Physical Barrier: None.

B2.16 241-Z-8 Settling Tank

The 241-Z-8 Settling Tank is a horizontal cylindrical vessel located 1.8 m (6 ft) below grade. The area above the tank is surrounded by a lightweight chain barricade marked "Caution Underground Radioactive Material" and inactive miscellaneous underground storage tank signs. Inside the barricade on the north end are two capped 10 cm (4-in.) steel vent pipes.

The dimensions of the settling tank are 12.2 m (40 ft) high with a diameter of 2.4 m (8 ft) and an overburden of 1.8 m (6 ft). The tank was used as a solids settling tank for back flushes of the RECUPLEX feed filters. Silica gel was used as a settling agent. The solids and silica gel were flushed to the 241-Z-8 Settling Tank with nitric acid. Overflow from the tank went to the 216-Z-8 French Drain, located approximately 11 m (36 ft) east of the settling tank.

After tank pumping, a sample of sludge beneath the 10.16 cm (4-in.) riser on October 22, 1974, contained 0.02 g/L of plutonium. This concentration calculates to a residual inventory of 0.084 lb (38 g) of plutonium.

As discussed in the process history (see Figure 2-17 in the FS report), there is a small possibility that the tank has leaked, contaminating surrounding soils. While the available data do not show that the tank has leaked, any leaks would contaminate soils at depths (approximatel 1.83 m or 6 ft bgs) that would be accessible to ecological receptors.

B2.16.1 Ecological Exposure Scenario Assessment

Factors contributing to exposure:

Habitat Type: None.

Cover Thickness: The site is covered with 1.8 m (6 ft) of backfill.

Physical Barrier: Yes.

Active Management: This site is managed by CH2M HILL Hanford, Inc., to include, at a minimum, annual surveillance and maintenance inspections.

B3.0 Screening-Level Ecological Risk Characterization

The approach used for this screening-level ecological risk assessment has been to develop a ecological conceptual model that describes the potential exposure pathways from contaminants in waste site soils to plants, soil invertebrates (ants) and wildlife. This ecological conceptual model then was compared with waste site information to identify the potential for complete exposure pathways.

Under current conditions, placement of soil covers and active management precludes exposure pathways to ecological receptors at all of these sites. However, determining if remedial alternatives are needed to protect ecological receptors requires that potential ecological exposures and risks be considered under baseline conditions; in this case, baseline conditions means assuming that the soil covers would no longer be maintained and that other active management methods would no longer be performed. Active management at the DOE decontamination and decommissioning-managed sites includes: (1) visual inspection performed three times a year to look for evidence of subsidence or animal intrusion, (2) a surface radiological survey performed once a year and any areas where radiation is detected covered with soil or posted for further action, (3) herbicide application performed two or three times a year to control any vegetation, and (4) pesticides applied as needed to control ants, termites, mice, and badgers. The exposure potential to ecological receptors is not of concern because of management practices at all sites.

Under baseline conditions, ecological exposure pathways could be present to contaminants in soil to a depth ranging from 10 to 15 feet below ground surface. A depth of 10 feet below ground surface represents a likely depth of the biologically-active zone, which could be penetrated by substantial root masses from deeply-rooted plants and from which soils could be exhumed by insects or burrowing mammals. The depth of 15 feet reflects the standard point of compliance for protection of ecological receptors as described in WAC 173-340-7490(4)(b).

The results from the comparison of the conceptual ecological exposure model with the waste site information, presented in Section B2.0, allows classification of the waste sites in terms of potential ecological exposure pathways likely to be complete and potential ecological exposure pathways unlikely to be complete. Waste sites where complete ecological exposure pathways are likely to be present are:

- 216-Z-1 and 216-Z-2 cribs
- 216-Z-12 crib
- 216-Z-18 crib
- 2126-Z-1A tile field
- 216-Z-3 crib
- 2126-Z-9 trench
- 216-A-24 crib
- 216-A-31 crib
- 216-A-7 crib
- 216-A-8 crib
- UPR-200-E-56
- 2126-Z-5 crib

Waste sites where complete ecological exposure pathways are not likely to be present are:

- 241-Z-361 settling tank
- 216-Z-10 reverse well
- 216-Z-8 french drain
- 241-Z-8 settling tank

Ecological exposures were not characterized as part of this screening-level ecological risk assessment. Characterization of ecological exposures was not required to help determine if remedial action was needed for these waste sites. For all of the waste sites, concentrations in soil were associated with human health risks, or presented a potential threat to groundwater. It is anticipated that at least one of the remedial alternatives evaluated in the FS (an alternative evaluating removal, treatment and disposal of soils to a depth of 15 feet) for protection of human health or groundwater also would address contaminants potentially posing a threat to ecological receptors. Therefore, for the purposes of the detailed evaluation of remedial alternatives, quantitative assessment of ecological exposures and risks was not. However, the demonstration that cleanup of contaminated soils will also protect ecological receptors will be addressed as part of remedial design/remedial action (RD/RA). Ecological screening values or preliminary remediation goals (PRGs), which can be used for confirmation sampling, will be identified in the Remedial Action Work Plan (RAWP) for the 200-PW-1, 200-PW-3 and 200-PW-6 sites.

B4.0 References

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Appendix C

Potential Applicable or Relevant and Appropriate Requirements

Contents

Tables

Terms

ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ISV	in situ vitrification
MCL	maximum contaminant level
OU	operable unit
PCB	polychlorinated biphenyl
ppm	parts per million
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
SVE	soil vapor extraction
TBC	to be considered
TSCA	*Toxic Substances Control Act of 1976*
USC	United States Code
WAC	*Washington Administrative Code*

Appendix C

Potential Applicable or Relevant and Appropriate Requirements

C1.0 Identification of Potential Applicable or Relevant and Appropriate Requirements for the 200-PW-1/3/6 Operable Units

This appendix identifies and evaluates potential applicable or relevant and appropriate requirements (ARAR) for waste site remediation in the 200-PW-1/3/6 Operable Units (OU). The potential ARARs identified in this appendix have been used to form the basis for the levels to which contaminants must be remediated to protect human health and the environment as required by 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan." Independent of the ARARs identification process at the Hanford Site, the requirements of U.S. Department of Energy (DOE) directives must be met.

Because the waste sites in the 200-PW-1/3/6 OUs will be remediated under a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) decision, remedial and corrective actions at the sites will be required to meet ARARs. As required under Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), this CERCLA remedial investigation/feasibility study process also will satisfy *Resource Conservation and Recovery Act of 1976* (RCRA) corrective action requirements. This appendix identifies and evaluates potential ARARs for these waste sites. Final ARARs for remediation will be established in the record of decision. In some cases, the ARARs form the basis for the preliminary remediation goals to which contaminants must be remediated to protect human health and the environment. In other cases, the ARARs define or restrict how specific remedial measures can be implemented.

The ARARs identification process is based on CERCLA guidance (EPA/540/G-89/006, *CERCLA Compliance with Other Laws Manual: Interim Final*, and EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, OSWER Directive 9355.3-01). Section 121 of CERCLA (as amended) requires, in part, that any applicable or relevant and appropriate standard, requirement, criterion, or limitation promulgated under any Federal environmental law, or any more stringent state requirement promulgated pursuant to a state environmental statute, be met (or a waiver justified) for any hazardous substance, pollutant, or contaminant that will remain onsite after completion of remedial action.

"Applicable" means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable.

"Relevant and appropriate" requirements means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate. In evaluating the relevance and appropriateness of a requirement, the eight comparison factors in 40 CFR 300.400(g)(2), "General," are considered:

(i) The purpose of the requirement and the purpose of the CERCLA action.

(ii) The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site.

(iii) The substances regulated by the requirement and the substances found at the CERCLA site.

(iv) The actions or activities regulated by the requirement and the remedial action contemplated at the CERCLA site.

(v) Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site.

(vi) The type of place regulated and the type of place affected by the release or CERCLA action.

(vii) The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action.

(viii) Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the CERCLA site.

In addition, potential ARARs were evaluated to determine if they fall into one of three categories: chemical-specific, location-specific, or action-specific. These categories are defined as follows:

- Chemical-specific requirements are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of public- and worker-safety levels and site-cleanup levels.
- Location-specific requirements are restrictions placed on the concentration of dangerous substances or the conduct of activities solely because they occur in special geographic areas.
- Action-specific requirements are usually technology- or activity-based requirements or limitations triggered by the remedial actions performed at the site.
- Further details on potential ARARs that fall into these categories are contained in Section C1.2.

In summary, a requirement is applicable if the specific terms or jurisdictional prerequisites of the law or regulations directly address the circumstances at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if (1) circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirement and (2) the requirement's use is well suited to the site. Only the substantive requirements (e.g., use of control/containment equipment, compliance with numerical standards) associated with ARARs apply to CERCLA onsite activities. ARARs associated with administrative requirements, such as permitting, are not applicable to CERCLA onsite activities (CERCLA, Section 121[e][1]). In general, this CERCLA permitting exemption will be extended to all remedial and corrective action activities conducted at the 200-PW-1/3/6 OUs.

To be considered (TBC) information is nonpromulgated advisories or guidance issued by Federal or state governments that is not legally binding and does not have the status of potential ARARs. In some circumstances, TBCs will be considered along with ARARs in determining the remedial action necessary for protection of human health and the environment. The TBCs complement the ARARs in determining protectiveness at a site or implementation of certain actions. For example, because soil cleanup standards do not exist for all contaminants, health advisories, which would be TBCs, may be helpful in defining appropriate remedial action goals.

C1.1 Waivers from Applicable or Relevant and Appropriate Requirements

The U.S. Environmental Protection Agency (EPA) may waive ARARs and select a remedial action that does not attain the same level of site cleanup as that identified by the ARARs. Section 121 of the *Superfund Amendments and Reauthorization Act of 1986* identifies six circumstances in which the EPA may waive ARARs for onsite remedial actions. The six circumstances are as follows:

- The remedial action selected is only a part of a total remedial action (such as an interim action), and the final remedy will attain the ARAR upon its completion.
- Compliance with the ARAR will result in a greater risk to human health and the environment than alternative options.
- Compliance with the ARAR is technically impracticable from an engineering perspective.
- An alternative remedial action will attain an equivalent standard of performance through the use of another method or approach.
- The ARAR is a state requirement that the state has not consistently applied (or demonstrated the intent to apply consistently) in similar circumstances.
- In the case of Section 104 (Superfund-financed remedial actions), compliance with the ARAR will not provide a balance between protecting human health and the environment and the availability of Superfund money for response at other facilities.

No waivers are being requested for the 200-PW-1/3/6 OUs.

C1.2 Potential Applicable or Relevant and Appropriate Requirements Applicable to Remedial Actions for Waste Sites in the 200-PW-1/3/6 Operable Units

Potential Federal and state ARARs are presented in Tables C-1 and C-2, respectively. The chemical-specific ARARs likely to be most relevant and appropriate to remediation of the 200-W-1/3/6 OUs are Federal regulations that implement drinking water standards (40 CFR 141, "National Primary Drinking Water Regulations") and WAC 173-340-720(7)(b), "Model Toxics Control Act—Cleanup," "Ground Water Cleanup Standards," that are used in this FS report for protection of groundwater evaluation.

Action-specific ARARs that could be pertinent to remediation are state solid and dangerous waste regulations (for management of characterization and remediation of wastes and performance standards for waste left in place).

Regarding waste management activities during remediation, a variety of waste streams may be generated under the preferred remedial action alternatives. It is anticipated that most of the waste will be designated as low-level waste and some will designate as transuranic waste. However, quantities of dangerous or mixed waste, polychlorinated biphenyl (PCB)-contaminated waste, and asbestos and asbestos-containing material also could be generated. The great majority of the waste will be in a solid form.

The identification, storage, treatment, and disposal of hazardous waste and the hazardous component of mixed waste generated during the remedial action would be subject to the substantive provisions of RCRA. In the State of Washington, RCRA is implemented through WAC 173-303, "Dangerous Waste Regulations," which is an EPA-authorized State RCRA program. The substantive portions of the dangerous waste standards for generation and storage would apply to the management of any dangerous or mixed waste generated during this remedial action. Treatment standards for dangerous or mixed waste that is subject to RCRA land disposal restrictions are specified in WAC 173-303-140, "Land Disposal Restrictions," which incorporates 40 CFR 268, "Land Disposal Restrictions," by reference.

The *Toxic Substances Control Act of 1976* (TSCA) and regulations at 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," govern the management and disposal of PCB wastes. The TSCA regulations contain specific provisions for PCB waste, including PCB waste that contains a radioactive component. PCBs also are considered underlying hazardous constituents under RCRA and thus could be subject to WAC 173-303 and 40 CFR 268 requirements for wastes that also designate as hazardous or mixed wastes.

Removal and disposal of asbestos and asbestos-containing material are regulated under the *Clean Air Act of 1990*, and 40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Subpart M, "National Emission Standard for Asbestos." These regulations provide for special precautions to prevent environmental releases or exposure to personnel of airborne emissions of asbestos fibers during remedial actions. Packaging requirements are identified in 40 CFR 61.52, "Emission Standard." Asbestos and asbestos-containing material would be removed, packaged as appropriate, and disposed of in the Environmental Restoration Disposal Facility (ERDF).

Waste designated as low-level waste that meets ERDF acceptance criteria is assumed to be disposed of at ERDF, which is engineered to meet appropriate performance standards of 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste." In addition, waste designated as dangerous or mixed waste would be treated as appropriate to meet land-disposal restrictions and ERDF acceptance criteria, and would be disposed of at ERDF. ERDF is engineered to meet minimum technical requirements for landfills under WAC 173-303-665, "Landfills." Applicable packaging and pre-transportation requirements for dangerous or mixed waste generated at the 200-PW-1/3/6 OUs would be identified and implemented before any waste was moved. Alternate disposal locations may be considered when the remedial action occurs, if a suitable and cost-effective location is identified. Any potential alternate disposal location other than ERDF will be approved by the lead regulatory agency and will be evaluated for appropriate performance standards to ensure that it is adequately protective of human health and the environment.

Following lead regulatory agency approval, waste designated as transuranic will be stored at the Central Waste Complex with eventual disposal at a geologic repository such as the Waste Isolation Pilot Plant.

Waste designated as PCB remediation waste likely would be disposed of at ERDF, depending on whether it is low-level waste and meets the waste acceptance criteria. PCB waste that does not meet ERDF waste acceptance criteria would be retained at a PCB storage area that meets the requirements for TSCA storage and would be transported for future treatment and disposal at an appropriate disposal facility following lead regulatory agency approval.

CERCLA Section 104(d)(4) states that where two or more noncontiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, the facilities can be treated as one for purposes of CERCLA response actions. Consistent with this, the 200-PW-1/3/6 OUs and ERDF would be considered to be onsite for purposes of Section 104 of CERCLA, and waste may be transferred between the facilities without requiring a permit.

All remedial alternative actions will be performed in compliance with the waste management ARARs. Waste streams will be evaluated, designated, and managed in compliance with the ARAR requirements. Before disposal, waste will be managed in a protective manner to prevent releases to the environment or unnecessary exposure to personnel.

The remedial action alternatives (see Chapter 5.0) have the potential to generate airborne emissions of both radioactive and criteria/toxic pollutants.

The *Revised Code of Washington* (RCW) 70.94, "Public Health and Safety," "Washington Clean Air Act," requires regulation of radioactive air pollutants. The state implementing regulation WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," sets standards that are as stringent or more so than the Federal *Clean Air Act of 1990* and Amendments (42 USC 7401, et seq.), and under the Federal implementing regulation, 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities." EPA's partial delegation of the 40 CFR 61 authority to the State of Washington includes all substantive emissions monitoring, abatement, and reporting aspects of the Federal regulation. The state standards protect the public by conservatively establishing exposure standards applicable to even the maximally exposed public individual. Under the *Washington Administrative Code* [WAC 246-247-030(15), "Radiation Protection—Air Emissions," "Definitions,"], the "Maximally exposed individual" is any member of the public (real or hypothetical) who abides or resides in an unrestricted area, and may receive the highest total effective dose equivalent from the emission unit(s) under consideration, taking into account all exposure pathways affected by the radioactive air emissions. All combined radionuclide airborne emissions from the DOE Hanford Site "facility" are not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent. The state implementing regulation WAC 246-247, which adopts the WAC 173-480 standards and the 40 CFR 61, Subpart H standard, requires verification of compliance with the 10 mrem/yr standard, and would potentially be applicable to the remedial alternatives.

The WAC 246-247 further addresses emission sources emitting radioactive airborne emissions by requiring monitoring of such sources. Such monitoring requires physical measurement of the effluent or ambient air. The substantive provisions of WAC 246-247 that require monitoring of radioactive airborne emissions would be applicable to the remedial alternatives.

The above state implementing regulations further address control of radioactive airborne emissions where economically and technologically feasible (WAC 246-247-040(3) and -040(4), "General Standards," and associated definitions). To address the substantive aspect of these requirements, best or reasonably achieved control technology will be addressed by ensuring that applicable emission control technologies (those successfully operated in similar applications) will be used when economically and technologically feasible (i.e., based on cost/benefit). If it is determined that there are substantive aspects of the requirement for control of radioactive airborne emissions, then controls will be administered as appropriate using reasonable and effective methods.

Under WAC 173-400, "General Regulations for Air Pollution Sources," and WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," requirements are established for the regulation of emissions of criteria/toxic air pollutants. The primary nonradioactive emissions resulting from these remedial alternatives will be fugitive particulate matter and the treated air from the SVE system and Alternative 2 – ISV hood system. In accordance with WAC 173-400-040, "General Standards for Maximum Emissions," reasonable precautions must be taken to (1) prevent the release of air contaminants associated with fugitive emissions resulting from excavation, materials handling, or other operations; and (2) prevent fugitive dust from becoming airborne from fugitive sources of emissions. The use of treatment technologies as part of the SVE and ISV remedy components that would result in emissions of toxic air pollutants would be subject to the substantive applicable requirements of WAC 173-460. Treatment of some waste encountered during the removal action may be required to meet ERDF or WIPP waste acceptance criteria. In most cases, the type of treatment anticipated would consist of solidification/ stabilization techniques, and WAC 173-460 would not be considered an ARAR. If more aggressive treatment is required that would result in the emission of regulated air pollutants, the substantive requirements of WAC 173-400-113(2), "Requirements for New Sources in Attainment or Unclassifiable Areas," and WAC 173-460-060"Control Technology Requirements," would be evaluated to determine applicability.

Emissions to the air will be minimized during implementation of any of the remedial alternatives through use of standard industry practices such as the application of water sprays and fixatives. These techniques are considered to be reasonable precautions to control fugitive emissions as required by the regulatory standards.

Table C-1. Identification of Potential Federal Applicable or Relevant and Appropriate Requirements and to be Considered for the Remedial Action Sites

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
		"National Primary Drinking Water Regulations," 40 CFR 141	
"Maximum Contaminant Levels for Organic Contaminants," 40 CFR 141.61	ARAR	Establishes MCLs that are drinking water criteria designed to protect human health from the potential adverse effects of organic contaminants in drinking water.	The groundwater beneath the 200-PW-1/3/6 OUs is not currently used for drinking water. However, Central Plateau groundwater may be considered a potential drinking water source and, because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in 40 CFR 141.61 for organic constituents are relevant and appropriate. This requirement is chemical-specific.
"Maximum Contaminant Levels for Inorganic Contaminants," 40 CFR 141.62	ARAR	Establishes MCLs that are drinking water criteria designed to protect human health from the potential adverse effects of inorganic contaminants in drinking water.	The groundwater beneath the 200-PW-1/3/6 OUs is not currently used for drinking water. However, Central Plateau groundwater may be considered a potential drinking water source and, because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in 40 CFR 141.62 for inorganic constituents are relevant and appropriate. This requirement is chemical-specific.
"Maximum Contaminant Levels for Radionuclides," 40 CFR 141.66	ARAR	Establishes MCLs that are drinking water criteria designed to protect human health from the potential adverse effects of radionuclides in drinking water.	The groundwater beneath the 200-PW-1/3/6 OUs is not currently used for drinking water. However, Central Plateau groundwater may be considered a potential drinking water source and because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in 40 CFR 141.66 for radionuclides are relevant and appropriate. This requirement is chemical-specific.

Table C-1. Identification of Potential Federal Applicable or Relevant and Appropriate Requirements and to be Considered for the Remedial Action Sites

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," 40 CFR 761			
"Applicability" Specific Subsections: 40 CFR 761.50(b)(1) 40 CFR 761.50(b)(2) 40 CFR 761.50(b)(3) 40 CFR 761.50(b)(4) 40 CFR 761.50(b)(7) 40 CFR 761.50(c)	ARAR	These regulations establish standards for the storage and disposal of PCB wastes.	The substantive requirements of these regulations are relevant and appropriate to the storage and disposal of PCB liquids, items, remediation waste, and bulk product waste at ≥50 ppm. The specific subsections identified from 40 CFR 761.50(b) reference the specific sections for the management of PCB waste type. The disposal requirements for radioactive PCB waste are addressed in 40 CFR 761.50(b)(7). This requirement is chemical-specific.
Archeological and Historic Preservation Act of 1974, et seq. 16 USC 469a-1 through 469a-(2)d	ARAR	Requires that remedial actions at 200-PW-1/3/6 OU waste sites do not cause the loss of any archaeological or historic data. This act mandates preservation of the data and does not require protection of the actual waste site or facility.	Archeological and historic sites have been identified within the 200 Areas; therefore, the substantive requirements of this act are applicable to actions that might disturb these sites. This requirement is location-specific.
National Historic Preservation Act of 1966, et seq. 16 USC 470, Section 106	ARAR	Requires Federal agencies to consider the impacts of their undertaking on cultural properties through identification, evaluation and mitigation processes, and consultation with interested parties.	Cultural and historic sites have been identified within the 200 Areas, and therefore the substantive requirements of this act are applicable to actions that might disturb these types of sites. This requirement is location-specific.
Native American Graves Protection and Repatriation Act of 1990, 25 USC 3001, et seq.	ARAR	Establishes Federal agency responsibility for discovery of human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony.	Substantive requirements of this act are applicable if remains and sacred objects are found during remediation and will require Native American Tribal consultation in the event of discovery. This requirement is location-specific.
Endangered Species Act of 1973, 16 USC 1531, et seq., Subsection 16 USC 1536(c)	ARAR	Prohibits actions by Federal agencies that are likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. If remediation is within critical habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect the resource.	Substantive requirements of this act are applicable if threatened or endangered species are identified in areas where remedial actions will occur. This requirement is location-specific.

Table C-1. Identification of Potential Federal Applicable or Relevant and Appropriate Requirements and to be Considered for the Remedial Action Sites

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"National Emission Standard for Asbestos," 40 CFR 61, Subpart M; "Applicability," 40 CFR 61.140			
"Standard for Demolition and Renovation," 40 CFR 61.145	ARAR	Specifies that facilities are to be inspected for the presence of asbestos before demolition. The standard defines regulated asbestos-containing materials and establishes removal requirements based on quantity present and handling requirements. These requirements also specify handling and disposal requirements for regulated sources that have the potential to emit asbestos. Specifically, no visible emissions are allowed during handling, packaging, and transport of asbestos-containing materials.	Although asbestos-containing materials are not anticipated, substantive requirements of this standard are applicable, should this remedial action include abatement of asbestos and asbestos-containing materials on pipelines or buried asbestos. As a result, there is a potential to emit asbestos to unrestricted areas, and the requirements for the removal, handling, and packaging of asbestos apply. This requirement is chemical-specific.
"Standard for Waste Disposal for Manufacturing, Fabricating, Demolition, Renovation, and Spraying Operations," 40 CFR 61.150	ARAR	Identifies the requirements for the removal and disposal of asbestos from demolition and renovation activities.	Although asbestos-containing materials are not anticipated, the substantive requirements of this standard are applicable, should asbestos-containing material be located during remedial action activities of associated pipelines and buried asbestos. This requirement is chemical-specific.

ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
MCL = maximum contaminant level
PCB = polychlorinated biphenyl
ppm = parts per million
TBC = to-be-considered
WAC = *Washington Administrative Code*

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Dangerous Waste Regulations," WAC 173-303			
"Identifying Solid Waste," WAC 173-303-016	ARAR	Identifies those materials that are and are not solid wastes.	Substantive requirements of these regulations are applicable, because these define how to determine which materials are subject to the designation regulations. Specifically, materials that are generated for removal from the CERCLA site during the remedial action would be subject to the procedures for identification of solid waste to ensure proper management. This requirement is action-specific.
"Recycling Processes Involving Solid Waste," WAC 173-303-017	ARAR	Identifies materials that are and are not solid wastes when recycled.	Substantive requirements of these regulations are applicable, because these define how to determine which materials are subject to the designation regulations. Specifically, materials that are generated for removal from the CERCLA site during the remedial action would be subject to the procedures for identification of solid waste to ensure proper management. This requirement is action-specific.
"Designation of Dangerous Waste," WAC 173-303-070(3)	ARAR	Establishes the method for determining whether a solid waste is, or is not, a dangerous waste or an extremely hazardous waste.	Substantive requirements of these regulations are applicable to materials encountered during the remedial action. Specifically, solid waste that is generated for removal from the CERCLA site during this remedial action would be subject to the dangerous waste designation procedures to ensure proper management. This requirement is action-specific.
"Excluded Categories of Waste," WAC 173-303-071	ARAR	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050, "Department of Ecology Cleanup Authority").	The conditions of this requirement are applicable to remedial actions in the 200-PW-1/3/6 OUs, should wastes identified in WAC 173-303-071 be encountered. This requirement is action-specific.
"Conditional Exclusion of Special Wastes," WAC 173-303-073	ARAR	Establishes the conditional exclusion and the management requirements of special wastes, as defined in WAC 173-303-040, "Definitions."	Substantive requirements of these regulations are applicable to materials encountered during the remedial action. Specifically, the substantive standards for management of special waste are applicable to the interim management of certain waste that will be generated during the remedial action. This requirement is action-specific.

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Requirements for Universal Waste," WAC 173-303-077	ARAR	Identifies those wastes exempted from regulation under WAC 173-303-140 and WAC 173-303-170 through 173-303-9907 (excluding WAC 173-303-960, "Special Powers and Authorities of the Department"). These wastes are subject to regulation under WAC 173-303-573, "Standards for Universal Waste Management."	Substantive requirements of these regulations are applicable to materials encountered during the remedial action. Specifically, the substantive standards for management of universal waste are applicable to the interim management of certain waste that will be generated during the remedial action. This requirement is action-specific.
"Recycled, Reclaimed, and Recovered Wastes," WAC 173-303-120 Specific Subsections: WAC 173-303-120(3) WAC 173-303-120(5)	ARAR	These regulations define the requirements for recycling materials that are solid and dangerous waste. Specifically, WAC 173-303-120(3) provides for the management of certain recyclable materials, including spent refrigerants, antifreeze, and lead-acid batteries. WAC 173-303-120(5) provides for the recycling of used oil.	Substantive requirements of these regulations are applicable to certain materials that might be encountered during the remedial action. Recyclable materials that are exempt from regulation as dangerous waste and that are not otherwise subject to CERCLA as hazardous substances can be recycled and/or conditionally excluded from certain dangerous waste requirements. This requirement is action-specific.
"Land Disposal Restrictions," WAC 173-303-140(4)	ARAR	This regulation establishes state standards for land disposal of dangerous waste and incorporates, by reference, Federal land-disposal restrictions of 40 CFR 268 that are applicable to solid waste that is designated as dangerous or mixed waste in accordance with WAC 173-303-070(3).	The substantive requirements of this regulation are applicable to materials encountered during the remedial action. Specifically, dangerous/mixed waste that is generated and removed from the CERCLA site during the remedial action for offsite (as defined by CERCLA) land disposal would be subject to the identification of applicable land-disposal restrictions at the point of generation of the waste. The actual offsite treatment of such waste would not be an ARAR to this remedial action, but instead would be subject to all applicable laws and regulations. This requirement is action-specific.
"Requirements for Generators of Dangerous Waste," WAC 173-303-170	ARAR	Establishes the requirements for dangerous waste generators.	Substantive requirements of these regulations are applicable to materials encountered during the remedial action. Specifically, the substantive standards for management of dangerous/mixed waste are applicable to the interim management of certain waste that will be generated during the remedial action. For purposes of this remedial action, WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200, "Accumulating Dangerous Waste On-Site," by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630, "Use and Management of Containers," and WAC 173-303-640, "Tank Systems," by reference. This requirement is action-specific.

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Requirements," WAC 173-303-64620(4)	ARAR	Requires Corrective Action to be "consistent with" specified section in WAC 173-340	The substantive portions of this regulation establish minimum requirements for HWMA corrective action.
	ARAR	Establishes the requirements for the Hanford Site storage of solid wastes that are not radioactive or dangerous wastes.	Substantive requirements of these regulations are applicable to materials encountered during the remedial action. Specifically, nondangerous, nonradioactive solid wastes (i.e., hazardous substances that are only regulated as solid waste) that will be containerized for removal from the CERCLA site would be managed at the Hanford Site according to the substantive requirements of this standard. This requirement is action-specific.
"Model Toxics Control Act–Cleanup," WAC 173-340			
"Ground Water Cleanup Standards," WAC 173-340-720(7)(b)	ARAR	Permits an adjustment of an existing state or federal cleanup standard downward so that the total excess cancer risk does not exceed 1 x 10^{-5} and the hazard index does not exceed 1.	The groundwater beneath the 200-PW-1/3/6 OUs is not currently used for drinking water. However, Central Plateau groundwater may be considered a potential drinking water source and, because the groundwater discharges to the Columbia River (which is used for drinking water), the substantive requirements in WAC 173-340-720(7)(b) are relevant and appropriate. This requirement is chemical-specific.
"Soil Cleanup Standards for Industrial Properties," WAC 173-340-745(5)(b)	ARAR	Establishes the process and methods used to evaluate direct contact risk to human health and the environment and to develop cleanup standards for soil and other environmental media.	Soil in the 200-PW-1/3/6 OU contains contaminants that require remediation. The substantive requirements of the specified subsections are pertinent to developing cleanup standards for the selected remedy for the 200-PW-1/3/6 Operable Unit. This is a chemical-specific requirement.
"Deriving Soil Concentrations for Ground Water Protection," WAC 173-340-747(3)	ARAR	Establishes the process and methods used to evaluate soil concentration that may cause an impact to human health and the environment through the groundwater and to develop cleanup standards for soil and other environmental media.	Soil in the 200-PW-1/3/6 OU contains contaminants that require remediation. The substantive requirements of the specified subsections are pertinent to developing cleanup standards for the selected remedy for the 200-PW-1/3/6 Operable Unit. This is a chemical-specific requirement.
"Site-specific Terrestrial Ecological Evaluation Procedures," WAC 173-340-7493(3)	ARAR	Establishes the process and methods used to evaluate soil concentration that may cause an impact to terrestrial ecology and to develop cleanup standards for soil and other environmental media.	Soil in the 200-PW-1/3/6 OU contains contaminants that require remediation. The substantive requirements of the specified subsections are pertinent to developing cleanup standards for the selected remedy for the 200-PW-1/3/6 Operable Unit. This is a chemical-specific requirement.

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Solid Waste Handling Standards," WAC 173-350			
"On-Site Storage, Collection and Transportation Standards," WAC 173-350-300	ARAR	Establishes the requirements for the temporary storage of solid waste in a container at the Hanford Site and the collecting and transporting of the solid waste.	The substantive requirements of this newly promulgated rule are relevant and appropriate to the Hanford Site collection and temporary storage of solid wastes at the 200-PW-1/3/6 OUs remediation waste sites. Compliance with this regulation is being implemented in phases for existing facilities. This requirement is action-specific.
"Minimum Standards for Construction and Maintenance of Wells," WAC 173-160			
"How Shall Each Water Well Be Planned and Constructed?" WAC 173-160-161	ARAR	Identifies well planning and construction requirements.	The substantive requirements of this regulation are ARAR to actions that include construction of wells used for groundwater extraction, monitoring, or injection of treated groundwater or wastes. The requirements of WAC 173-160-161, 173-160-171, 173-160-181, 173-160-400, 173-160-420, 173-303-430, 173-160-440, 173-160-450, and 173-160-460 are relevant and appropriate to groundwater well construction, monitoring, or injection of treated groundwater or wastes in the 200-PW-1/3/6 OUs. These requirements are action-specific.
"What Are the Requirements for the Location of the Well Site and Access to the Well?" WAC 173-160-171	ARAR	Identifies the requirements for locating a well.	
"What Are the Requirements for Preserving the Natural Barriers to Ground Water Movement Between Aquifers?" WAC 173-160-181	ARAR	Identifies the requirements for preserving natural barriers to groundwater movement between aquifers.	
"What Are the Minimum Standards for Resource Protection Wells and Geotechnical Soil Borings?" WAC 173-160-400	ARAR	Identifies the minimum standards for resource protection wells and geotechnical soil borings.	
"What Are the General Construction Requirements for Resource Protection Wells?" WAC 173-160-420	ARAR	Identifies the general construction requirements for resource protection wells.	
"What Are the Minimum Casing Standards?" WAC 173-160-430	ARAR	Identifies the minimum casing standards.	
"What Are the Equipment Cleaning Standards?" WAC 173-160-440	ARAR	Identifies the equipment cleaning standards.	

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"What Are the Well Sealing Requirements?" WAC 173-160-450	ARAR	Identifies the well sealing requirements.	
"What Is the Decommissioning Process for Resource Protection Wells?" WAC 173-160-460	ARAR	Identifies the decommissioning process for resource protection wells.	
"General Regulations for Air Pollution Sources," WAC 173-400			
"General Standards for Maximum Emissions," WAC 173-400-040 and "Requirements for New Sources in Attainable or Unclassifiable Areas," WAC 173-400-113	ARAR	Methods of control shall be employed to minimize the release of air contaminants associated with fugitive emissions resulting from materials handling, construction, demolition, or other operations. Emissions are to be minimized through application of best available control technology.	Substantive requirements of these standards are relevant and appropriate to this remedial action, because there may be visible, particulate, fugitive, and hazardous air emissions and odors resulting from decontamination, demolition, and excavation activities. As a result, standards established for the control and prevention of air pollution are relevant and appropriate. These requirements are action-specific.
"Controls for New Sources of Toxic Air Pollutants," WAC 173-460			
"Applicability," WAC 173-460-030 and "Control Technology Requirements," WAC 173-460-060	ARAR	Requires that new sources of air emissions provide the emission estimates identified in this regulation.	Substantive requirements of these standards are applicable to this remedial action, because there is the potential for toxic air pollutants to become airborne as a result of decontamination, demolition, and excavation activities. As a result, standards established for the control of toxic air contaminants are relevant and appropriate. These requirements are action-specific.
"Ambient Impact Requirement," WAC 173-460-070	ARAR	Requires that when applying for a notice of construction, the owner/operator of a new toxic air pollutant source that is likely to increase toxic air pollutant emissions shall demonstrate that emissions from the source are sufficiently low to protect human health and safety from potential carcinogenic and/or other toxic effects.	The substantive requirements of this standard are applicable to remedial actions in the 200-PW-1/3/6 OUs, should the remedial action result in the treatment of the soil or debris that contains contaminants of concern identified in the regulation as a toxic air pollutant. This requirement is action-specific.
"Ambient Air Quality Standards and Emission Limits for Radionuclides," WAC 173-480			
"General Standards for Maximum Permissible Emissions," WAC 173-480-050(1)	ARAR	Whenever another Federal or state regulation or limitation in effect controls the emission of radionuclides to the ambient air, the more stringent control of emissions shall govern.	The substantive requirements of this standard are applicable in that the more stringent aspect of Federal or state emission limitation is specified as governing. This requirement is action-specific.

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Emission Monitoring and Compliance Procedures," WAC 173-480-070(2)	ARAR	Requires that radionuclide emissions compliance shall be determined by calculating the dose to members of the public at the point of maximum annual air concentration in an unrestricted area where any member of the public may be.	The substantive requirements of this standard are applicable to remedial actions involving disturbance or ventilation of radioactively contaminated areas or structures, because airborne radionuclides may be emitted to unrestricted areas where any member of the public may be. This requirement is action-specific.
"Radiation Protection – Air Emissions," WAC 246-247			
"National Standards Adopted by Reference for Sources of Radionuclide Emissions," WAC 246-247-035(1)(a)(ii)	ARAR	Establishes requirements equivalent to 40 CFR 61, Subpart H. Radionuclide airborne emissions from the facility shall be controlled so as not to exceed amounts that would cause an exposure to any member of the public of greater than 10 mrem/yr effective dose equivalent.	Substantive requirements of this standard are applicable because a remedial action may include activities such as excavation, decontamination, and stabilization of contaminated areas and equipment, and operation of exhausters and vacuums, each of which may provide airborne emissions of radioactive particulates to unrestricted areas. As a result, requirements limiting emissions apply. This is a risk-based standard for the purposes of protecting human health and the environment. These requirements are action-specific.
"General Standards," WAC 246-247-040(3) WAC 246-247-040(4)	ARAR	Emissions shall be controlled to ensure that emission standards are not exceeded. Actions creating new sources or significantly modified sources shall apply best available controls. All other actions shall apply reasonably achievable controls.	Substantive requirements of this standard are applicable because fugitive, diffuse, and point source emissions of radionuclides to the ambient air may result from remedial activities, such as excavation of contaminated soils and operation of exhauster and vacuums, performed during the remedial action. This standard exists to ensure compliance with emission standards. These requirements are action-specific.
"Monitoring, Testing, and Quality Assurance" WAC 246-247-075(1) and –(2) and –(4)	ARAR	Establishes the monitoring, testing, and quality assurance requirements for radioactive air emissions from major sources. Effluent flow rate measurements shall be made and the effluent stream shall be directly monitored continuously with an inline detector or representative samples of the effluent stream shall be withdrawn continuously from the sampling site following the specified guidance. The requirements for continuous sampling are applicable to batch processes when the unit is in operation. Periodic sampling (grab samples) may be used only with lead agency prior approval. Such approval may be granted in cases where continuous sampling is not practical and radionuclide emission rates are relatively constant. In such cases, grab samples shall be collected with	Substantive requirements of this standard are applicable when fugitive and nonpoint source emissions of radionuclides to the ambient air may result from activities, such as excavation of contaminated soils and operation of exhauster and vacuums, performed during a remedial action. This standard exists to ensure compliance with emission standards. This requirement is action-specific.

Table C-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Site

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
		sufficient frequency so as to provide a representative sample of the emissions. When it is impractical to measure the effluent flow rate at a source in accordance with the requirements or to monitor or sample an effluent stream at a source in accordance with the site selection and sample extraction requirements, the facility owner or operator may use alternative effluent flow rate measurement procedures or site selection and sample extraction procedures as approved by the lead agency. Emissions from nonpoint and fugitive sources of airborne radioactive material shall be measured. Measurement techniques may include, but are not limited to, sampling, calculation, smears, or other reasonable method for identifying emissions as determined by the lead agency.	
"Monitoring, Testing, and Quality Assurance," WAC 246-247-075(3)	ARAR	Methods to implement periodic confirmatory monitoring for minor sources may include estimating the emissions or other methods as approved by the lead agency.	Substantive requirements are applicable when fugitive and diffuse emissions from any excavation and related activities occur and will require periodic confirmatory measurements to verify low emissions. This requirement is action-specific.
"Monitoring, Testing, and Quality Assurance," WAC 246-247-075(8)	ARAR	Facility (site) emissions resulting from nonpoint and fugitive sources of airborne radioactive material shall be measured. Measurement techniques may include ambient air measurements, or inline radiation detector or withdrawal of representative samples from the effluent stream, or other methods as determined by the lead agency.	Substantive requirements are applicable when fugitive and diffuse emissions of airborne radioactive material due to excavation and related activities occur and will require measurement. This requirement is action-specific.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR = *Code of Federal Regulations*
OU = operable unit
TBC = to be considered
WAC = *Washington Administrative Code*

C2.0 References

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Appendix D

Cost Estimate Backup

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Terms

AFL-CIO	American Federation of Labor-Congress of Industrial Organizations
ALARA	as low as reasonably achievable
CDF	control density fill
CHPRC	CH2M HILL Plateau Remediation Company
CWC	Central Waste Complex
ERDF	Environmental Restoration Disposal Facility
FH	Fluor-Hanford
FICA	*Federal Insurance Contributions Act*
FP	fixed price
FS	feasibility study
G&A	general and administrative
HEPA	high-efficiency particulate air
HSSA	*Hanford Site Stabilization Agreement*
INL	Idaho National Laboratory
ISV	in situ vitrification
MAESTRO Estimator	Estimating Program used by Fluor Hanford
N/A	not applicable
QA	quality assurance
RCT	radiological control technician
RTD	removal, treatment, and disposal
SVE	soil-vapor extraction
SWB	standard waste box
WAC	*Washington Administrative Code*
WIPP	Waste Isolation Pilot Plant

Appendix D

Cost Estimate Backup

D1.0 Introduction

The cost estimates for the feasibility study (FS) are developed in accordance with guidance specified in EPA/540/R-00/002, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, OSWER 9355.0-75. The cost estimates provide a discriminator for deciding between similar protective and implemental alternatives for a specific waste site. The CH2M HILL Plateau Remediation Company (CHPRC) Project Controls and Estimating department used the MAESTRO Estimator software to develop the cost estimates for the various alternatives presented for each of the waste sites.

The estimates are based on actual pricing information derived from historical experience. The units used may have been factored/adjusted by the estimator and/or task lead, as appropriate, to reflect influences by the contract, work site, or other identified special conditions. Historical information from similar Hanford Site planning and construction well drilling efforts was applied to this estimate.

Tables D-1 through D-30 present the costs for the alternatives as present net worth values. These tables should be used in conjunction with Table 2-17 of the main document to evaluate the costs by waste group. The present net worth value method is used to evaluate costs that occur during different periods and allows for cost comparisons of alternatives based on a single cost number for each alternative. The present net worth value represents the dollars that would need to be set aside today to ensure that funds would be available in the future, as they are needed to execute the remedial alternative.

Present net worth costs are estimated using the real discount rate published in Appendix C of OMB Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, effective through January 2008. Programs with durations longer than 30 years use the 30-year interest rate of 3.0 percent. Present net worth costs are discussed for each alternative in the following subsections.

EPA/540/R-00/002 recommends including the non-discounted costs in the FS. Non-discounted constant dollar costs demonstrate the impact of a discount rate on the total present worth cost. The non-discounted costs are calculated for 350- and 1,000-year durations and are presented for comparison purposes only.

This FS does not evaluate the economies associated with implementing multiple sites or groups with a common alternative or aggregated remediation. These aspects will be considered in the future as part of long-range planning and through the post-record of decision activities, such as remedial design. Potential areas of cost sharing to reduce overall remediation costs include the following:

- Remediating all waste sites with a common Preferred Alternative at the same time
- Sharing mobilization/demobilization costs
- Sharing surveillance and maintenance costs
- Sharing barrier performance monitoring costs

Chapter D2.0 provides a basic breakdown of the cost estimates developed for each alternative for each of the waste sites. These cost estimates are based on EPA/540/R-00/002.

Major assumptions are discussed in Chapter D3.0. These assumptions are necessary to provide the level of detail needed for independent review.

D2.0 Cost Estimates of the Alternatives

The remedial alternatives for each of the waste sites are discussed in detail in Chapters 5.0 and 6.0 of this FS. This appendix summarizes the alternatives described in the FS and provides backup information and assumptions used in developing the cost estimates for each of the remedial alternatives.

D2.1 200-PW-1 Operable Unit (OU)

Four remedial alternatives are considered for the sites within 200-PW-1 OU. Activities that are common to all but the No Action Alternative include institutional controls, revegetation of the site, expanded soil-vapor extraction (SVE) operation for an additional 10 years at the High-Salt waste sites (assumed for cost estimating purpose), site-specific monitoring, and groundwater monitoring. Institutional controls, site-specific monitoring, and groundwater monitoring are included in the cost estimates for a duration of 1,000 years. Details of these common activities are presented in Section 5.2.1 of the FS.

The following four alternatives were analyzed as part of the detailed analysis:

- **Alternative 0–No Action:** This action has an assumed cost of $0.
- **Alternative 1–Construct a Physical Barrier with or without CDF Backfill:** This alternative operates an expanded SVE system for 10 years at the High-Salt waste sites. Then, following decommissioning of the SVE wells, barriers will be constructed at each waste site. Physical barriers will be constructed at the High-Salt waste sites to impede intrusion into the contaminants. ET barriers will also be constructed at each site (except the 216-Z-9 Trench) to limit infiltration. Controlled density fill (CDF) will be used to fill the 216-Z-9 Trench and waste sites with significant subsurface void spaces, where appropriate. Alternative 1 is discussed in Section 5.2.2.
- **Alternative 2–In Situ Vitrification (ISV):** This alternative operates an expanded SVE system for 10 years at the High-Salt waste sites. ISV is performed to create a glass monolith that is 5 to 6 m (16 to 20-ft) thick and covers the dimensions of the waste sites. The waste sites will then be backfilled to grade and revegetated. Additional details are presented in Section 5.2.3.
- **Alternative 3–Partial to Complete Removal, Treatment, and Disposal (RTD):** This alternative operates an expanded SVE system for 10 years at the High-Salt waste sites. Following decommissioning of the SVE system and associated wells at year 11, the sites will be excavated. All the waste designated as transuranic waste and will be packaged for disposal at the Waste Isolation Pilot Plant (WIPP). Waste designated as mixed low-level waste will be managed and packaged as appropriate for disposal at the Environmental Restoration Disposal Facility (ERDF). Additional details are presented in Section 5.2.4. There are five options within this Alternative:
  - **Case 3a:** Remove highest plutonium concentrations by RTD to 0.6 m (2 ft) below the base of wastes site;
  - **Case 3b:** Remove direct contact risk less than 4.5 m (15 ft) below ground surface;
  - **Case 3c:** Remove significant plutonium mass;
  - **Case 3d:** Remove greater than 100 nCi/g transuranic concentrations; and
  - **Case 3e:** Remove plutonium so that long-term institutional controls at a waste site are not needed.

  An ET barrier will be constructed over most of the sites after backfilling to grade.

The various components of each alternative are then combined to determine the total cost for each alternative. These values are used in the detailed analysis presented in Chapter 6.0.

Tables D-1, D-2, and D-3 provide an overview of the site information used for the cost estimates. This includes the site information, the volumes that need to be excavated and/or backfilled, and details of any treatment that may be occurring. Tables D-9A, D-9B, D-10A, D-10B, D-11A, and D-11B present capital costs for each alternative. Tables D-17, D-18, and D-19 present capital costs, periodic costs, non-discounted cost, and the total present worth costs for each alternative. Table D-20 compares present net worth and non-discounted costs.

D2.2 200-PW-3 Operable Unit

Three remedial alternatives are considered for the sites within the 200-PW-3 OU. Several activities are common to all the remedial alternatives. They consist of institutional controls, revegetation of the site, site-specific monitoring, and groundwater monitoring. Institutional controls, site-specific monitoring, and groundwater monitoring are included for a duration of 350 years. Details of these common activities are presented in Section 5.2.1 of the FS.

The following four alternatives were analyzed as part of the detailed analysis.

- **Alternative 0 – No Action:** This action has an assumed cost of $0.
- **Alternative 1 – Construct an Evapotranspiration (ET) Barrier:** An ET barrier will be constructed over each waste site. The site will then be revegetated. Additional details are presented in Section 5.2.2.
- **Alternative 2 – In Situ Vitrification (ISV):** This alternative is not evaluated for this OU.
- **Alternative 3 – Partial to Complete Removal, Treatment, and Disposal (RTD):** The sites will be excavated and all excavated material designated as regulated waste will be managed and packaged as appropriate for disposal at ERDF. Additional details are presented in Section 5.2.4. The two options within this Alternative include: Case 3b - remove direct-contact risk less than 4.5 m (15 ft) below ground surface and Case 3c–remove significant Cesium-137 mass. ET barriers will be constructed over most of the sites after backfilling.

The various components of each alternative then are combined to determine the total cost for each alternative. These values are used in the detailed analysis presented in Chapter 6.0.

An overview of the site information used for the cost estimates is provided in Table D-4 (Barriers) and Table D-5 (Remove, Treat, and Dispose). This includes the site information, the volumes that need to be excavated and/or backfilled, and details of any treatment that may be occurring. Tables D-12 and D-13 present capital costs for each alternative. Tables D-21, D-22, and D-26 present capital costs, periodic costs, non-discounted cost, and the total present worth costs for each alternative. Table D-23 compares present net worth and non-discounted costs.

D2.3 200-PW-6 Operable Unit

Four remedial alternatives are considered for the sites within the 200-PW-6 OU. Several activities are common to all the remedial alternatives and consist of institutional controls, revegetation of the site, site-specific monitoring, and groundwater monitoring. Institutional controls, site-specific monitoring, and groundwater monitoring are included for a duration of 1,000 years. Details of these common activities are presented in Section 5.2.1 of the FS.

The following four alternatives were analyzed as part of the detailed analysis.

- **Alternative 0 – No Action:** This action has an assumed cost of $0.
- **Alternative 1 – Construct a Physical Barrier and CDF Backfill:** The sites with voids will be backfilled with CDF, where appropriate, and then a physical barrier will be constructed over the site. The site will then be revegetated. Additional details are presented in Section 5.2.2.
- **Alternative 2 – In Situ Vitrification (ISV):** ISV is performed to create a glass monolith that is 5 to 6 m (16- to 20-ft) thick and covers the dimensions of the waste site. The waste site will then be backfilled to grade and revegetated. Additional details are presented in Section 5.2.3.
- **Alternative 3 – Partial to Complete Removal, Treatment, and Disposal (RTD):** The sites will be excavated. Waste designated as transuranic waste will be packaged for disposal at the WIPP. Waste designated as mixed, low-level waste will be managed and packaged as appropriate for disposal at ERDF. Additional details are presented in Section 5.2.4. The four options within this Alternative include:
  - Case 3a–Remove highest plutonium concentrations by RTD to 0.6 m (2 ft) below the base of wastes site;
  - Case 3c–Remove significant plutonium mass;
  - Case 3d–Remove greater than 100 nCi/g transuranic concentrations; and
  - Case 3e–Remove plutonium so that long-term institutional controls at a waste site are not needed.

  An ET barrier will be constructed over most of the sites after backfilling to grade.

The various components of each alternative are then combined to determine the total cost for each alternative. These values are used in the detailed analysis presented in Chapter 6.0.

Tables D-6, D-7, and D-8 provide an overview of the site information used for the cost estimates. This includes the site information, the volumes that need to be excavated and/or backfilled, and details of any treatment that may be occurring. Tables D-14, D-15, and D-16 present capital costs for each alternative. Tables D-24 and D-25 present capital costs, periodic costs, non-discounted costs, and the total present worth costs for each alternative. Table D-27 compares present net worth and non-discounted costs.

D2.4 241-Z-361 Settling Tank

A previous engineering evaluation and cost assessment was performed on the 241-Z-361 Settling Tank in 2003 (DOE/RL-2003-52, *Tank 241-Z-361 Engineering Evaluation/Cost Analysis*). This report recommended an alternative for sludge removal that employs a Power Fluidic[1] system to loosen and homogenize the sludge and transfer it to standard waste boxes (SWB). WaterWorks SP-400 Superabsorbent Crystals[2] are added to the SWB to absorb residual liquids and stabilize the sludge. This SWB then will be transported to the Central Waste Complex (CWC) for storage and certification before shipment to WIPP. The empty tank will be closed in place according to *Washington Administrative Code* requirements by backfilling the tank with CDF. The original cost estimate in DOE/RL-2003-52 has been updated to include current costs and to incorporate shipment of the SWBs to WIPP and the tank closure activities involving the CDF. The tank dimensions are presented in Table D-3. Table D-11A presents

[1] Power Fluidics is a trademark of NuVision Engineering (formerly AEA Technology Engineering Services, Inc.).
[2] WaterWorks Crystals is a registered trademark of WaterWorks America, Inc.

capital costs for tank closure activities. Table D-19 presents the alternative costs broken down by capital costs, periodic costs, non-discounted cost, and the total present worth costs.

D2.5 216-Z-9 Trench

This site has several small buildings, a high-efficiency particulate air (HEPA) ventilation system, two glove boxes, a below roof slab control house structure, a below roof slab stairway and retrieval equipment built on, near, on top of, or below the existing trench roof. All of the structures will need to be removed prior to any work being performed at the 216-Z-9 Trench. The CHPRC baseline cost is $6,292,482 for removal and disposal. This cost is not included in the remedial cost for each of the alternatives since it is the same for all the alternatives.

D3.0 Basis of Estimates

The remedial alternatives for each of the waste sites are summarized in the previous chapter and discussed in detail in Chapters 5.0 and 6.0 of this FS. This chapter provides backup information and assumptions used in developing the cost estimates for each of the remedial alternatives.

D3.1 Global Assumptions

The following sections identify the labor, markups, and general global assumptions for the remedial alternatives cost estimates.

D3.1.1 Labor

- Fixed-price (FP) construction craft labor rates are those listed in Appendix A of the *Site Stabilization Agreement for All Construction Work for the U.S. Department of Energy at the Hanford Site* (commonly known as the Hanford Site Stabilization Agreement [HSSA]). The HSSA rates include base wage, fringe benefits, and other compensation as negotiated with the National Building and Construction Trades Department American Federation of Labor-Congress of Industrial Organizations (AFL-CIO). Other factors to cover additional costs (i.e., Workman's Compensation, *Federal Insurance Contributions Act* [FICA], and state and federal unemployment insurance) to develop a fully burdened rate by craft, have been incorporated. The labor rates used are for 2008.
- CHPRC labor rates for management, engineering, safety oversight, and technical support are based on the approved planning rates for fiscal year 2008.

D3.1.2 Markups

The following sections describe markups of direct and indirect cost factors.

D3.1.2.1 Direct Cost Factors

- Sales tax has been applied to all materials and equipment purchases at 8.3 percent.
- Construction consumables are estimated at 3.5 percent of FP direct craft labor costs to allow for small tools, tape, plastics, gloves, etc.
- A general supervisor factor of 3 percent has been applied to FP craft labor hours.
- A general requirements factor of 5 percent has been applied to cover incidental labor for hauling personnel and materials and to cover other miscellaneous labor.

D3.1.2.2 Indirect Cost Factors

- FP contractor overhead, profit, bond, and insurance costs have been applied at 26.5 percent on FP labor, materials, and equipment.
- CHPRC general and administrative (G&A) of 8.5 percent has been applied to all CHPRC labor, material, and equipment. G&A also is applied to the FP contractor costs.

D3.1.3 General Assumptions

- CHPRC cost estimating templates for site remediation are used as the basis for each waste site cost estimate.

- Construction labor, material, and equipment units are estimated based on standard commercial estimating resources and databases: Means 2001, *ECHOS Environmental Remediation Cost Data-Unit Price*; Means 2007, *Facility Construction Cost Data*; Richardson, 2001, *Process Plant Construction Estimating Standards*; and the EquipmentWatch, 2007, *Rental Rate Blue Book for Construction Equipment*. The units may have been factored or adjusted by the estimator as appropriate to reflect influences by contract, work site, or other identified project or special conditions.
- Quotes from local commercial sources are used for materials that need to be acquired for the construction of barriers or temporary improvements.
- Equipment rates are based on 21 working days per month.
- Equipment operation is based on one shift of 8 hours per day.
- Workweek equals 5 days per week.
- Work stoppages or shutdowns caused by inclement weather are not factored into the estimates or planning schedules for this study.
- Work delays or stoppages caused by waiting for laboratory results or approval for backfilling waste site excavations are not factored into the estimates or planning schedules for this study.
- The cost estimates include costs for design, work plan preparation, or any other preparation costs normally associated with activities occurring before field mobilization.
- Remedial design capital costs are based on EPA/540/R-00/002, Exhibit 5-8. The following guide is used in this study:
  - For projects with construction costs less than \$100,000–Remedial design is planned at 20 percent of construction costs.
  - For projects with construction costs from \$100,000 to \$500,000–Remedial design is planned at 15 percent of construction costs.
  - For projects with construction costs from \$500,000 to \$2 million–Remedial design is planned at 12 percent of construction costs.
  - For projects with construction costs from \$2 million to \$10 million–Remedial design is planned at 8 percent of construction costs.
  - For projects with construction costs greater than \$10 million–Remedial design is planned at 6 percent of construction costs.
- Escalation has not been included in the calculations. All costs presented in this appendix are derived from fiscal year 2008 rates, unless otherwise noted).
- Contingency rates are based on EPA/540/R-00/002, Section 5.4.
- All borrow source materials are assumed to come from Hanford sources. During the remedial design, the actual borrow source location will be identified and will comply with all *National Environmental Policy Act of 1969* requirements.

D3.2 No Action Alternative

The No Action Alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the waste site. Taking no action implies "walking away from the waste site" and allowing the waste to remain in its current configuration, affected only by natural processes. No maintenance or institutional controls are included in this alternative.

Because the No Action Alternative assumes that no further actions will be taken at a waste site, costs are assumed to be zero. However, there are costs associated with decommissioning 216-Z-10 and 216-Z-8 shown within Table 6-1 of main document.

D3.3 Institutional Controls

Institutional controls, which can have one-time or recurring costs (capital, annual operations and maintenance, or periodic), are non-engineering or legal/administrative measures used to reduce or minimize the potential for exposure to site contamination or hazards by limiting or restricting site access. Examples include institutional controls plans, restrictive covenants, property easements, zoning, deed notices, advisories, groundwater use restrictions, and site information databases. An institutional controls plan would describe the controls for a site and how they would be implemented. A site information database would provide a system for managing data necessary to characterize the current nature and extent of contamination. Institutional controls are project-specific costs that can be an important component of a remedial alternative and, as such, generally should be estimated separately from other costs, usually on a subelement basis. Institutional controls may need to be updated or maintained, either annually or periodically.

The institutional control cost model was developed by the CHPRC Project Controls and Estimating department. The duration for institutional controls only considers the initial, "year-one" period. The annual/periodic activities were based on 350- and 1,000-year durations.

The primary annual/periodic costs are associated with surveillance and cover maintenance, monitored natural attenuation, and long-term groundwater monitoring. The costs for these annual/periodic activities were estimated based on the area of the individual waste sites or groups.

The unit cost for surveillance and maintenance was assumed to be the same as the current unit cost for surveillance and maintenance activities conducted annually on the waste sites. The unit cost accounts for such activities as site radiation surveys, and repair of the existing soil cover on the sites where it is present. Because the existing soil cover is maintained annually, costs for replacing all or large portions of the existing cover at specified intervals (i.e., every 20 years) are considered unnecessary.

The costs associated with natural attenuation monitoring are divided into three components: radiological surveys of surface soils, spectral gamma logging of vadose zone boreholes, and groundwater monitoring. The costs to perform radiological surveys of surface soils at waste sites are assumed to be similar to those for current survey practices at the sites and are included in the surveillance and maintenance costs.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site for the full duration of institutional controls. This monitoring is considered for sites with high concentrations of contaminants in the shallow zone or near the bottom of crib and trench structures. It also assumes that the service life of vadose zone boreholes is 30 years. Costs are included for logging and periodic replacement of these boreholes for the full duration of institutional controls. Groundwater monitoring costs are described in detail in Section D3.3.3.

D3.3.1 General Assumptions

The general assumptions for institutional controls are below:

- Costs were calculated based on the specific area of each site.
- Site areas range from less than 139 m^2 (1,500 ft^2) to more than 4,645 m^2 (50,000 ft^2). Because the size range is not significant, the same-sized construction crews will be used for all sites.
- Fencing and monuments/signs for institutional controls and fencing maintenance are included.
- The proposed institutional controls consist of seven general activities: implementation of institutional controls, site inspection and surveillance, existing cover maintenance, natural attenuation monitoring, reporting, site reviews, and groundwater and vadose zone monitoring.
- The prices that make up the cost estimate were obtained from one of the following sources:
  - Means 2001, *ECHOS Environmental Remediation Cost Data–Unit Price*
  - Means 2007, *Facility Construction Cost Data*
  - Experience on similar projects.

D3.3.2 Special Conditions

The following sections identify issues that apply only to specific sites.

D3.3.3 Long-Term Groundwater Monitoring Costs

Each alternative, except the No Action Alternative, includes annual inspections and maintenance costs for periodic groundwater monitoring to ensure that the proposed vadose-zone remedies are achieving the desired objectives and not impacting groundwater. The cost associated with periodic groundwater monitoring is distributed equally over applicable closure zones. The following is a description of the estimating approach for the groundwater monitoring costs.

Periodic groundwater sampling will be performed in each closure zone located at the facility. Each closure zone will contain three monitoring wells that will be sampled during the periodic sampling event. The present worth cost for the periodic groundwater monitoring program will be the same for each closure zone. That cost then will be divided equally among the sites within that closure zone. A summary of the facility closure zones associated with this FS is presented below.

Closure Zone	Number of Sites in Each Closure Zone
200 East Area Pond	50
PUREX	101
Plutonium Finishing Plant	40

Based on historical information from similar Hanford Site planning, the cost to install a compliant monitoring well is approximately $180,000 per well. It is assumed that this cost includes all required labor and material:

- Cost to install wells (3 wells) = $180,000/well × 3 wells = $540,000

Maintenance will be performed on each of the wells every 5 years. In addition, each of the wells will be replaced once every 30 years:

- Maintenance costs (3 wells) = $5,000/well × 3 wells = $15,000 every 5 years

- Replacement costs (3 wells) = \$180,000/well × 3 wells = \$540,000 every 30 years

During each sampling event, three groundwater samples will be collected for analysis. The analyses and cost per analysis are listed below:

- Americium-241 = \$125/sample × 3 samples/event = \$375/event
- Plutonium-238, -239, -240, -241 = \$300/sample × 3 samples/event = \$900/event
- Volatile organic compounds = \$85/sample × 3 samples/event = \$255/event
- Technetium-99 = \$150/sample × 3 samples/event = \$450/event

Total analytical cost per sampling event = \$1,980.

The labor cost of doing all the paperwork, labeling, monitoring, and delivery to the laboratory is approximately \$300 per well sampled:

- Total labor cost = \$300/well × 3 wells = \$900/sampling event

Total cost to collect and analyze samples per sampling event = \$2,880.

Sampling events will occur at the following frequencies:

- Year 1 through 30 years (life) Semiannually (two sampling events)

The present worth cost to conduct a periodic groundwater monitoring program for each closure zone for 30 years was calculated.

The present worth cost for the long-term groundwater program is estimated at \$680,153.

As a comparison, the non-discounted present worth cost for the long-term groundwater program was calculated to compare the effect of a discount rate on the total project cost. The non-discounted cost for the long-term groundwater program is estimated at \$4,129,200.

Non-discounted costs are adjusted for each alternative to ensure they are included only once for the entire duration. Because each closure zone has a different number of sites, Table D-29 presents the long-term groundwater monitoring cost per site for each closure zone. The non-discounted long-term groundwater monitoring cost per site is presented in parentheses.

Lastly, Table D-30 lists the sites included in this FS, their associated closure zone, and the cost that will be added into the costs for the alternatives. Non-discounted costs are presented in parentheses.

D3.4 Barriers

Two types of barriers are used in this study, the ET Monofill and the Physical Barrier. Monofill ET barriers will be used in conjunction with an Alternative 3 RTD option. The Physical Barrier is the primary design used for Alternative 1 for the High-Salt and Low-Salt waste sites. Several exceptions use CDF backfill with or without an ET Monofill barrier. These exceptions are discussed in the Special Conditions section below. For planning purposes, the side overlap of barriers will be 6.1 m (20 ft) for all exterior sides. Figures D-1 and D-2 show details of the assumed barrier design for the ET Monofill and Physical barriers.

D3.4.1 General Assumptions

The general assumptions for this alternative are below.

All borrow source materials are assumed to come from a Hanford source. During the remedial design, the actual borrow source location will be identified and will comply with all *National Environmental Policy Act of 1969* requirements.

Fieldwork such as mobilization/demobilization, borrow site excavation, barrier fill, revegetation, and some of the post-construction work will be contracted to an FP contractor. Project management, radiological control technician (RCT) support, sampling, and safety oversight will be performed by CHPRC.

Mobilization and startup activities include site training, mobilization of equipment and personnel, installation of temporary construction fences, construction of access roads, and setting up offices and storage trailers with utilities.

Revegetation of the waste site barrier includes planting native dry-land grass using tractors with seed drills and hand broadcasting, hand planting sagebrush seedlings, and irrigation for four times in the spring or early summer. All disturbed areas, such as around the barrier, stockpile, staging areas, and access roads, will be replanted.

The CHPRC Project Management team consists of a part-time project manager, a full-time field supervisor, and part-time engineering support. QA, radiological control, and safety also provide oversight along with other support for contract management and project controls. Total hours for this staff are planned at 22.5 hours per day. The duration of this work is based on total project duration.

The FP contractor field supervisory team consists of a full-time construction manager and field supervisor, along with part-time QA, construction safety, and clerical support. Two pickup trucks are included in the cost. Total hours for this staff are planned at 21 hours per day. The duration of this work is based on total project duration.

Demobilization will include demobilization of equipment and personnel, and removal of temporary construction fences, access roads, and office/storage trailers.

There are two Hanford sources for the fill materials to construct the three soil/fill layers. The source for engineered fill is located at Pit 30 approximately halfway between the 200 East and 200 West Areas. This pit is assumed to have the sufficient quantity for this project. The source for the silt required for Layers 1 and 2 is located at Area C about 2 mi south of the 200 West Area.

The sand, crushed base course, and fractured basalt will be supplied by offsite vendors or from commercial gravel pits. These materials are delivered to the waste site by the vendor.

All barrier sites are considered to have settled and are compacted enough to support construction of a barrier without further settling. Dynamic compaction is not used to pre-compact the site.

The barrier sites are considered level and will not require additional pre-leveling before the start of construction.

The ET monofill barrier will consist of three different layers (See Figure D-1):

- The bottom layer will be constructed of 20 cm (8 in.) of engineered fill. The construction of the engineered fill requires the excavation of suitable borrow from a Hanford pit source. The estimated time to complete the fill is based on the production rate of a 5-yd^3 loader excavating at the pit. All material is screened with a grizzly mounted on a surge bin to remove 10 cm (4 in.) or larger rocks. Five 16-yd^3 end dump trucks with 16-yd^3 trailers are needed to keep up with the loader. One 4,000-gal. water truck provides dust control at the pit. The production rate for this work is 141 m^3/hr

(185 yd^3/hr). The spreading and compaction equipment used at the barrier is a 250- to 300-hp dozer with a U-blade to spread fill, and two 12-ton vibratory tandem rollers. A 4,000-gal. water truck provides dust control.

- To produce a smooth surface to prevent low areas, the surface of engineered fill is fine-graded. Work involves a 5-yd^3 loader, 12-ton vibratory single drum roller, a laser-leveling equipped dozer, and a water truck. The production rate is 2090 m^2/hr (2,500 yd^2/hr) to fine-grade the fill surface area. One laborer supports the grader operator as a grade checker. Two engineer technicians set up the grade and elevation control.

- A biobarrier layer will be constructed over the waste site, before the bottom layer of fill is constructed, when the depth of the cover or overburden soil is less than 4.5 m (15 ft). This layer is made of ballast gravel spread 0.3 m (1 ft) deep over the waste site. The area of the ballast layer covers an additional 3 m (10 ft) on each side of the waste site and a slope distance of 0.9 m (3 ft). On top of the ballast layer is spread 10 cm (4 in.) of 1.6 cm (5/8-in.) crushed-top course gravel. The process for the construction of this layer involves a 5-yd^3 loader, 300-hp dozer, water truck, and vibratory compactor for spreading and compacting the layer over the waste site. The gravel is from a commercial source and has been stockpiled near the waste site before building the layer. The production rate is 229 m^3/hr (300 yd^3/hr) for spreading and compacting the layer. One laborer supports the three equipment operators and the water truck driver.

- The second layer will be constructed of 68 cm (27 in.) of silt fill. The construction of this layer involves excavating and hauling the silt from the Hanford pit to the barrier. This layer is 51 cm (20 in.) deep. The estimated time to complete the fill is based on the production rate of a 5-yd^3 loader excavating at the pit. Five 16-yd^3 end dump trucks with 16-yd^3 trailers are needed to keep up with the loader. One 4,000-gal. water truck provides dust control at the pit. The production rate for this work is 141 m^3/hr (185 yd^3/hr). At the barrier, the silt is spread with two 90- to 120-hp low-ground pressure dozers. The silt is scarified to prevent overcompaction. A truck with a 4,000-gal. water trailer provides dust control at the barrier.

- The top layer will be constructed of 30 cm (12 in.) of silt/pea gravel fill. This layer requires a fill material consisting of silt with 15 percent pea gravel added by weight. The silt is excavated with a 4- to 5-yd^3 loader and hauled from the site silt source by two dump trucks to a process area near the pit. Pea gravel will be provided from a commercial source. The supplier will haul and stockpile the gravel at the silt process area. A 4- to 5-yd^3 loader and a pug mill with belt loader are used to mix the silt and gravel. The hauling from the process area is the same as described for the second layer. Spreading also is the same as the second layer. The side slopes of the barrier will be covered with 0.3 m (1-ft) deep fractured basalt with silt to fill in the void spaces in the rock.

- The side slopes of the barrier will be fine-graded before placing fractured basalt. The work involves a 100- to 150-hp dozer with laser controls, a 4- to 5-yd^3 loader, one 12-ton vibratory single drum roller, and a water tanker. The production rate is 2,090 m^2/hr (2,500 yd^2/hr) for the engineered fill surface area. One laborer supports the dozer operator and the water truck driver. Two engineer technicians set up the grade and elevation control.

- A geotextile is placed on the side slopes. This item of work covers the placement of needle-punched 120-mil polypropylene geotextile on the side slopes. The production rate is 250 m^2/hr (300 yd^2/hr). Three laborers place and splice the fabric. One operator with a 2.5-yd^3 loader and a truck driver with a flatbed truck support the work.

- The top layer of the side slopes is covered with 30 cm (12-in.) deep fractured basalt with silt. The fractured basalt is from a commercial source and is delivered to the site by the supplier. The silt is from the Hanford pit and is hauled to the barrier. The equipment used to spread the basalt is a 5-yd^3 loader, 300 hp dozer with rippers, and one-quarter-time 4,000 gal. water truck. Two equipment operators and one-quarter-time truck driver operate the equipment. One laborer supports the operators as a grade checker and helps place fractured basalt. The placement of the silt involves excavating at the pit, hauling to the barrier, and spreading on the fractured basalt. This work occurs at the same time as the placement of the fractured basalt to ensure the silt is worked into the basalt. The excavation and hauling from the pit uses one 5-yd^3 loader and three 16-yd^3 end dump trucks with 16-yd^3 trailers. The placement and mixing with the basalt use one 5-yd^3 loader. A 4,000-gal. water truck is used for dust control. Two operators, four truck drivers, and one laborer operate the equipment and support the work. The production rate for this work is 53 m^3/hr (70 yd^3/hr).

- Instrumentation is not included for these barriers.

The Physical barrier will consist of four different layers (see Figure D-2):

- The bottom layer will be constructed of 122 cm (48 in.) of fractured basalt. The top 0.3 m (1 ft) of the fill will be mixed with crushed ballast rock. Fractured basalt and crushed ballast rock will be provided from a commercial source. The supplier will haul and dump the material near or on the waste site. The process for the construction of the basalt layer involves a motor grader, 300 hp dozer, water truck, and vibratory compactor for spreading and compacting the layer over the waste site. The production rate is 114 m^3/hr (150 yd^3/hr) for spreading and compacting the layer. One laborer supports the three equipment operators and the water truck driver. The process for mixing the upper 0.3 m (1 ft) of the fill with crushed ballast rock involves two motor graders, loader, water truck, and two vibratory compactors. The production rate is 159 m^3/hr (208 yd^3/hr) for mixing, spreading, and compacting the layer of crushed ballast.

- The second layer will be 91 cm (36 in.) of engineered fill. The construction process will be the same as described above.

- The third layer will be 68 cm (27 in.) of silt fill. The construction process will be the same as described above.

- The top layer will be constructed of 30 cm (12 in.) of silt/pea gravel fill. The construction process will be the same as described above.

- The side slopes of the barrier will be same as described above.

- Instrumentation is not included for these barriers.

After completion of the barrier construction work, a 1.2 m (4-ft) steel post with chain fence will be built around the site. The fence location is at the toe of the barrier slope.

Operation and maintenance costs for the Barrier Alternative include barrier performance monitoring and repair costs. For purposes of this FS, all sites will assume annual repairs to the barrier (replacement of 15.2 cm [2 ft] of topsoil layer and revegetation over 10 percent of the barrier area). This is considered a conservative estimate because the barrier has been designed to require minimal maintenance, particularly after vegetation has been established.

During the construction of the barrier, compaction testing will be performed on the different layers. The bottom and sand layers will require that a minimum level of compaction has been reached. The top two layers will be tested to ensure that the fill does not become overcompacted.

D3.4.2 Special Conditions

The following sections identify issues that apply only to specific sites.

D3.4.2.1 216-Z-1A – Below Ground Physical Barrier

The existing site is a tile drain field that is located approximately 2.4 m (8 ft) below the existing ground surface. The physical barrier will be built inside the depression area. The fractured basalt layer, engineered fill, silt, and pea gravel/silt layers will all be constructed the same as described above and to the same depths. Since the barrier as designed is 3.1 m (10.3 ft) tall and the waste site is 2.4 m (8 ft) deep, approximately 0.7 m (2.3 ft) of silt fill will be above the surrounding area. A shortened fractured basalt side slope will be constructed around the raised silt layer (see Figure D-3).

D3.4.2.2 216-Z-1, 2, 3 – CDF Backfill of Crib and Physical Barrier

The three sites are all below ground structures, with 216-Z-1 and 216-Z-2 being timber crib structures and 216-Z-3 being constructed of metal culvert sections. Prior to constructing the Physical Barrier over the cribs, each crib is to be backfilled with pumped CDF. If the existing pipe opening cannot be used for pumping, the structures will be excavated and a small opening made into the top of the structures. CDF will then be pumped into the hollow sections of the cribs until CDF has completely filled the voids. After the CDF has hardened, the sites will be backfilled and compacted. The Physical Barrier will then be constructed over the site.

D3.4.2.3 216-Z-9 – CDF Backfill of Trench and Leave Roof in Place with ET Monofill

This site is a below ground trench with a concrete roof. After all buildings and equipment have been removed from the site, the trench will be backfilled with pumped CDF until the void area under the concrete roof is completely filled. There are several openings in the existing trench roof, so no new opening will be required prior to the start of the CDF pumping process. The existing concrete roof will remain in place.

D3.4.2.4 216-Z-1, 2, 3, and Z-1A – Barrier Overlap

The cost estimates for the barrier alternative at each of these waste sites treated each site separately. These four waste sites are located close enough to each other that if individual barriers were constructed over each waste site they would overlap. The potential cost savings from the barrier overlap at these four sites was not quantified because it was expected to be less than the +50 percent to -30 percent accuracy of the cost estimates.

D3.5 Soil Vapor Extraction

An SVE system mainly consists of screened wells located at various depths in the vadose zone and an applied vacuum (e.g., blower) that is used to extract the vapor from the vadose zone.

The number of wells and the depth of the screening are specific to each waste site and will be finalized during remedial design. For estimating purposes, the number of additional wells to increase coverage or target specific known contamination layers has been estimated at 10 wells with a screened depth of 45.7 m (150 ft) for each of the three waste sites.

D3.5.1 General Description and Assumptions

The following sections describe the general description and assumptions of well construction, operation and maintenance, and decommissioning.

D3.5.1.1 Well Construction

The general assumptions for SVE well construction are below.

Work activities include planning and documentation, technical coordination, procurement, labor, subcontracts, materials, equipment, field support during construction, waste management, and project closeout.

Well Planning: Prepare and/or obtain the necessary documentation to support well installations. Where possible, use or modify existing documentation to plan the work. Subtasks include, but are not limited to, the following:

- Stake wells and walk down
- Prepare Description of Work for installation of wells with data sheets
- Prepare Sampling and Analysis Instructions and Data Quality Objective Waste Summary Report
- Conduct cultural resources review
- Conduct ecological resources review
- Perform ground-penetrating radar surveys for underground utilities
- Update Site-Specific Waste Management Instructions
- Prepare drilling contract from Description of Work and data sheets
- Prepare necessary permits (e.g., excavation)
- Prepare preliminary hazard classification, hazard survey, and radiological assessment.

Well Installation: Tasks include the following:

- Prepare subcontract documents
- Prepare well pads
- Drill and install wells
- Conduct civil surveys of well locations
- Provide management support, labor support, and associated documentation
- Close out activities.

Fieldwork such as mobilization/demobilization, site preparation, drilling, well completion, development, and some of the post-construction work will be contracted to an FP contractor. Project management, RCT support, sampling, and safety oversight will be performed by CHPRC.

CHPRC work activities also include planning and documentation, technical coordination, procurement, labor, subcontracts, materials, equipment, field support during construction (e.g., buyer's technical representative), waste management, and project closeout.

Waste management activities include providing management oversight for waste associated with the installation of wells. Waste management includes the disposal of soil, groundwater, and miscellaneous waste sampling as needed during well installations, well operations, and miscellaneous waste disposal. Waste management support includes waste sampling and evaluations, profiling, labeling, disposal costs, and management. Tasks include the following:

- Provide office and field supervision, and RCT/industrial hygiene technicians as required to support waste management activities.
- Provide manual/nonmanual labor, subcontracts, and project management for those activities.
- Collect two soil samples from waste containers from each boring.
- Dispose of cuttings (assumes approximately three-quarters of soil cuttings will be returned to the environment at the wellhead and approximately one-fourth of the soil will be disposed to ERDF).

FP contractor mobilization and startup include site training; mobilization of equipment and personnel; installation of temporary construction fences; and construction of drill pads, access roads, and decontamination areas. The length and width of the access roads and the size of the drill pad will vary as a function of the topography and building/utility constraints. The contractor will clear and grub vegetation for the well pad and road. The roads and drill pads will be constructed of pit run gravel and topped with 3.2 cm (1.25-in.) minus crushed rock.

The FP contractor provides and manages all labor, material, equipment, and testing/ inspection services required to complete a fully functional monitoring well to Hanford Site standards. The drilling equipment will be steam cleaned or decontaminated before use at a drill site and before being removed from the site. The FP contactor will supply and install the temporary and permanent well casing and screens, along with the sand, grout, sealing bentonite clay, and SVE equipment. The FP contractor also will install the concrete well pad, protection post, and locking well cover. The FP contractor will manage the drumming of drilling waste before turnover to waste management. This also will include a forklift operator for drum handling after the drums are turned over to waste management. The contractor will provide crew and equipment for soil sampling during drill operations.

D3.5.1.2 Well Operation and Maintenance

A previous engineering evaluation and cost assessment was performed on the 200-PW-1 Carbon Tetrachloride SVE sites 2007 (SGW-37111 Revision 0, *Performance Evaluation Report for Soil Vapor Extraction Operations at the 200-PW-1 Operable Unit Carbon Tetrachloride Site, Fiscal Year 2007*). This information is the basis for the operation and maintenance costs. The costs shown in the study were averaged and then escalated to 2008 costs. The five activities covered by the study are the Design, Operations and Maintenance, Performance Monitoring, Project Support, and Waste Management. In addition, cost for replacing the flex hose assemblies every 3 years has been estimated and included. It is assumed that an offsite vendor will fabricate the needed replacement parts and install the hose at the well site.

D3.5.1.3 Well Decommissioning

The labor to remove the SVE system is assumed to cost 50 percent of the installation labor. The equipment is to be removed and stored for other projects. The hoses and associated material will be sent to ERDF for disposal. The wells will be decommissioned by grouting or plugged according to Washington State requirements.

D3.6 In Situ Vitrification

The ISV alternative will be used to vitrify contaminated soils beneath the trench, reducing the risk posed by direct contact with the material, and impeding intrusion into the residual untreated contaminants. The exact number and configuration of melts, and the components and configuration of the offgas treatment system, will be determined in the remedial design phase. Treatability testing most likely will be necessary to support design. Handling or disturbing the soil at these waste sites will require special considerations. Section D3.7.2.1 provides additional information.

D3.6.1 General Assumptions

The general assumptions for the ISV alternative are below.

Fieldwork such as mobilization/demobilization, excavation, backfill, revegetation, and some of the post-construction work will be contracted to an FP contractor. The project management, RCT support, sampling, and safety oversight will be performed by CHPRC. The waste disposal work involved with hauling from the site to ERDF and ERDF dumping cost/fees will be performed by the environmental restoration contractor responsible for ERDF.

Mobilization and startup include site training; mobilization of equipment and personnel; installation of temporary construction fences; construction of staging/container storage areas and access roads; and setting up office, change, and storage trailers with utilities, temporary survey buildings, and decontamination areas.

A layer of clean fill will be placed on top of the base soils to provide a working surface for placement of the electrodes and injection of conductive material between the electrodes. For sites with 1.5 m (5 ft) or more of clean overburden soil on top of a crib or trench, the overburden will be removed and stockpiled nearby. The process used to remove the overburden will be the same as described in Alternative 3.

Melts, including offgas treatment, are assumed to cost $1,775/metric ton ($1,615/ton), based on discussions with AMEC (supplier of the GeoMelt[3] technology). This unit rate includes cost for the melt subcontractor to bring in the melt equipment, hoods, control trailers, electrodes, etc, and personnel to operate the equipment. The cost of demobilization for the melt equipment is included in this unit rate.

The melts would result in a contiguous block of glass at the base of the waste site. Backfilling of the waste site will be required after the melts to match the surrounding ground surface. Backfilling consists of the following operations.

- Moving the stockpiled overburden back to the site will require one crew. The equipment used by a crew is one 5-yd^3 loader and two haul trucks. Labor is one operator and two truck drivers. The production rate for one crew is 141 m^3/hr (185 yd^3/hr).
- Moving borrow material to the site typically is performed by one crew hauling from a Hanford pit source. The equipment used by a crew is one 5-yd^3 loader, five 16-yd^3 end dump trucks with 16-yd^3 trailers, and one 4,000-gal. water truck. Labor is one operator and six truck drivers. The production rate for one crew is 141 m^3/hr (185 yd^3/hr).
- Spreading and compaction of the backfill at the site is performed by one crew. The equipment used per crew is one 300-hp dozer and one 4,000-gal. water truck. Labor consists of one operator, one truck driver, and one laborer. The production rate for one crew is 141 m^3/hr (185 yd^3/hr).

Revegetation of the waste site includes planting native dry-land grass using tractors with seed drills and hand broadcasting, hand-planting sagebrush seedlings, and irrigation for four times in the spring or early summer. All disturbed areas, such as around the waste site, stockpile, staging areas, and access roads, will be replanted.

[3] GeoMelt is a trademark of AMEC, London, England.

The PRC Project Management team consists of a part-time project manager with a full-time field supervisor and part-time engineering support. QA, radiological control, and safety also provide oversight, along with other support for contract management and project controls. Total hours for this staff are planned at 22.5 hours per day. The duration of this work is based on total project duration.

The FP contractor field supervisory team consists of a full-time construction manager and field supervisor, along with part-time QA, construction safety, and clerical support. Two pickup trucks are included in the cost. Total hours for this staff are planned at 21 hours per day. The duration of this work is based on total project duration.

Demobilization includes demobilization of equipment and personnel; removal of temporary construction fences; and construction of staging/container storage areas, access roads, office/change/storage trailers, temporary survey buildings, and decontamination areas.

The cost estimate does not include the following items:

- Additional site characterization to support design
- Treatability studies
- Infrastructure (e.g., line drop for ISV electrical demand, or the cost of electrical power)
- In-process addition of backfill materials to make up for subsidence
- Management/disposal of secondary waste streams from the offgas system
- Post-cooling evaluation of melt (seismics and soil sampling)

D3.6.2 Special Conditions

The following sections identify issues that apply only to specific sites.

D3.6.2.1 216-Z-1, 2, 3, and 5–Removal of Crib and Overburden before ISV

These waste sites are below ground crib structures. Before ISV remediation work can start the timber crib structures will need to be removed. The work will start by first removing all of the clean overburden soil and stockpiling it nearby. The structures will be demolished, removed, and placed in an ERDF container for disposal at ERDF. Any contaminated soil encountered at the sites will remain at the bottom of the excavation. The floor of the excavation will then be smoothed and prepped for the ISV work by spreading and smoothing any contaminated soil. After completion of the ISV work and the required cool-down period, the clean soil will be used to backfill the site. At 216-Z-3, the culverts will be collapsed prior to ISV.

D3.6.2.2 216-Z-9–Removal of Roof and ISV

Before ISV work can start, the roof will be removed from the trench. The process is the same as described in Section D3.7.3.1. At the completion of the ISV work and after the cool-down period, the trench will be backfilled with soil to the elevation of the surrounding ground surface.

D3.7 Removal, Treatment, and Disposal

Cribs, trenches, and other sites are excavated to the required depth, and contaminated material is removed to ERDF or WIPP for disposal. Excavation depth and mixing requirements are different for each of the waste sites.

D3.7.1 General Assumptions

The general assumptions for this alternative are below.

Fieldwork such as mobilization/demobilization, excavation, backfill, revegetation, and some of the post-construction work will be contracted to an FP contractor. Project management, RCT support, sampling, and safety oversight will be performed by CHPRC. The waste disposal work involved with hauling from the site to ERDF and ERDF dumping cost/fees will be performed by the environmental restoration contractor responsible for ERDF.

Mobilization and startup include site training; mobilization of equipment and personnel; installation of temporary construction fences; construction of staging/container storage areas and access roads; and setting up office, change, and storage trailers with utilities, temporary survey buildings, and decontamination areas.

The sites will have contaminated waste removed. The sides of the excavation will be sloped at 1.5:1 to the bottom of the excavation. During the removal process, heavy equipment will be kept out of the excavation.

For excavation sites, overburden will be removed with a 2- to 3-yd^3 excavator and two haul trucks. The soil will be stockpiled near the waste site. A highway truck with a water tank trailer is used to control dust during this activity. The production rate for one crew is 111 m^3/hr (146 yd^3/hr).

Contaminated waste will be excavated using a 2- to 3-yd^3 hydraulic crawler excavator. The contaminated soil will be directly placed into lined ERDF containers and hauled from the excavation site. A highway truck with a water tank trailer is used to control dust during this activity. Depending on the volume of waste to move, one to four crews can be working at a site. Crew labor consists of one operator, one laborer, and one truck driver. The production rate for one crew is 45 m^3/hr (60 yd^3/hr). An RCT supports the work at 1.5 hours per excavation crew hour.

Air sampling will be performed at the start of the remediation, completion of remediation, and every quarter of the year. A minimum of two samples will be taken per each sampling period. The planning cost per sample is $559. The sampling crew consists of one sampler and one RCT.

Soil samples will be taken of the overburden, from ERDF containers, and for verification at the completion of the excavation. The soil-sampling costs are based on the contaminants expected to be found at the sites and are below:

- Noncontaminated soil sampling
  - Maximum of six samples or one sample per 0.7 m^3 (1 yd^3), whichever is less
  - QA sample required: one
  - Planning cost per sample: $2,110
  - The soil being sampled is the overburden that is uncontaminated and will not be removed from the site
- Sampling required for waste going to ERDF
  - One sample is required for every 70 containers
  - There will be a minimum of six samples per site
  - QA samples required: a minimum of 1 sample or 5 percent of total ERDF samples, whichever is greater

  - Planning cost per sample: $486
- Pre-verification process sampling
  - One sample will be required per 2,500 m2 (50 × 50 m) (26,899 ft2)
  - There will be a minimum of six samples per site
  - QA samples required: a minimum of two samples or 5 percent of total the samples, whichever is greater
  - Planning cost per sample: $3,540
  - These are the preliminary samples needed to determine if all of the required waste has been removed from a site being excavated
  - This process is expected to occur twice during the excavation process
  - If the samples show that the site has met the requirement, the verification process will start
- Verification process sampling
  - One sample will be required per 625 m2 (25 × 25 m) (6,724 ft2)
  - There will be a minimum of six samples per site
  - One boring to 30.5 m (100 ft) to confirm the residual contamination at depth with samples collected every 1.5 m (5 ft) and analyzed for final COPCs
  - QA samples required: a minimum of 2 or 5 percent of total the samples, whichever is greater
  - Planning cost per sample: $11,417
  - These samples are the final samples needed to determine if all of the required waste has been removed from a site being excavated
  - This process occurs once during the excavation process
- Sampling crews
  - Verification sampling – 1 hour for each sample taken by a crew consisting of one CHPRC RCT and a sampler technician
  - Other sampling (air, ERDF, noncontaminated) – 2 hours for each sample taken by a crew consisting of one CHPRC RCT and one sampler technician

The ERDF container handling and loading process starts with a site haul truck picking up an empty container at the staging area. The container is moved to a preparation area where laborers install a bed liner, and then the container is inspected by a half-time RCT. The haul truck and container proceed to the loading area. After loading, the liner is sealed and the container is secured by laborers. The container is moved to the survey building where three RCTs inspect and survey the container and truck for contamination. From there, the haul truck and container are driven to the storage area. The container is unloaded from the truck at the storage area. Three trucks are required to support each contaminated excavation crew.

ERDF disposal fee, transportation, and handling costs are estimated at $868.85 per container. An environmental restoration contractor driver and truck/trailer will move a loaded container to ERDF and place an empty container in the staging area. The estimated costs include the rental of the containers used. For planning purposes, the capacity of an ERDF container is 10 m^3 (13 yd^3) of contaminated waste.

Backfilling consists of the following operations:

- Moving the stockpiled overburden back to the excavation site will require one crew. The equipment used by a crew is one 5-yd^3 loader and two haul trucks. Labor is one operator and two truck drivers. The production rate for one crew is 141 m^3/hr (185 yd^3/hr).
- Moving the borrow material to the excavation site typically is performed by one crew hauling from a Hanford pit source. The equipment used by a crew is one 5-yd^3 loader, five 16-yd^3 end dump trucks with 16-yd^3 trailers, and one 4,000-gal. water truck. Labor is one operator and six truck drivers. The production rate for one crew is 141 m^3/hr (185 yd^3/hr).
- Spreading and compaction of the backfill at the site is performed by one crew. The equipment used per crew is one 300-hp dozer and one 4,000-gal. water truck. Labor consists of one operator, one truck driver, and one laborer. The production rate for one crew is 141 m^3/hr (185 yd^3/hr).

Revegetation of the waste site includes planting native dry-land grass using tractors with seed drills and hand broadcasting, hand-planting sagebrush seedlings, and irrigation for four times in the spring or early summer. All disturbed areas, such as around the waste site, stockpile, staging areas, and access roads, will be replanted.

The CHPRC Project Management team consists of a part-time project manager, a full-time field supervisor, and part-time engineering support. QA, radiological control, and safety also provide oversight, along with other support for contract management and project controls. Total hours for this staff are planned at 22.5 hours per day. The duration of this work is based on total project duration.

The FP contractor field supervisory team consists of a full-time construction manager and field supervisor, along with part-time QA, construction safety, and clerical support. Two pickup trucks are included in the cost. Total hours for this staff are planned at 21 hours per day. The duration of this work is based on total project duration.

Demobilization includes demobilization of equipment and personnel; removal of temporary construction fences; and construction of staging/container storage areas, access roads, office/change/storage trailers, temporary survey buildings, and decontamination areas.

The cost estimates for each of the RTD alternative cases treated each of the waste sites separately. Several of the waste sites are located close enough to each other that if the RTD alternative cases were implemented at each of the following waste sites there would be overlap in the amount of overburden to be excavated, stockpiled, and replaced:

- Cases 3a and 3c – 216-Z-1, 2, 3, and Z-1A
- Cases 3d and 3e – 216-Z-1, 2, 3, Z-1A, and Z-18

The potential cost savings from the overlap in the amount of overburden to be excavated, stockpiled, and replaced at these sites was not quantified because it was expected to be less than the +50 percent to -30 percent accuracy of the cost estimates.

D3.7.2 Special Conditions

The following sections identify issues that apply only to specific sites for the RTD alternatives.

D3.7.2.1 200-PW-3 Sites: 216-A-7 Crib, 216-A-8 Crib, 216-A-24 Crib, and 216-A-31 Crib

Because of the nature of the contaminants at the 200-PW-3 sites, mixing of the contaminated soils is required before container loading and disposal. The RTD process will be the same as described above except contaminated soil will be mixed with clean soil from the site at a 2:1 basis.

Contaminated waste will be mixed and excavated using a 2- to 3-yd^3 hydraulic crawler excavator. The contaminated soil, after it has been mixed, will be placed directly into lined ERDF containers and hauled from the excavation site. A highway truck with a water tank is used to control dust during this activity. Crew labor consists of one operator, one laborer, and one truck driver. The production rate for one crew is 23 m^3/hr (30 yd^3/hr). An RCT supports the work at 1.5 hours per excavation crew hour and will ensure that the initial surveys of the soil will meet the requirements of ERDF-bound waste. The rest of the activities at the site will remain unchanged.

D3.7.3 Removal of Soil Containing Transuranic Radionuclides

Excavations at sites that include soil potentially containing transuranic radionuclides will require special handling of the packaged soil and disposal of that soil at WIPP. Excavation includes mobilization/demobilization, removal of clean soil, backfilling the site, and other site work. For the cost estimate, the volume of soil requiring disposal at WIPP was estimated based on the length and width dimensions of the bottom of the waste site and the depth of the dig for each RTD case as described in Chapter 5.0. The following assumptions apply:

- The contaminated soil is placed into WIPP SWB. For planning purposes, each box is expected to handle 1.15 m^3 (1.5 yd^3) of waste.
- The field crews can fill, cover, inspect, sample, radiological survey, and move two SWBs per hour. The boxes are direct-loaded with a small hydraulic excavator at the waste site.
- The filled SWBs are moved to a decontamination area, then to a field survey area before being temporarily staged at the waste-site container storage area.
- The SWB is field screen/surveyed at the site before shipment to the CWC. Two technicians, two scientists, and one equipment operator perform the field-screening work at the site.
- Waste shippers will provide oversight of the field operation and the required waste designation reports to support shipment to the CWC.
- After the initial field screening/survey of the waste, those SWBs determined to contain transuranic radionuclides are moved six SWBs per truckload to the CWC.
- The CWC will perform processing, headspace sampling, nondestructive analysis, and temporary storage. The waste storage rate is $12,872 per SWB.
- After completion and acceptance of the waste profile study, the SWBs are shipped to WIPP for storage. Six SWBs can be loaded on a truck for shipment to WIPP. The planning cost of one truck trip to WIPP is $12,500.
- At this time, there are no handling costs or storage rates for the SWBs after arriving at WIPP.

The cost estimates for each of the RTD alternative cases treated each of the waste sites separately. Several of the waste sites are located close enough to each other that if the RTD alternative cases were implemented at each of the following waste sites there would be overlap in the amount of overburden to be excavated, stockpiled, and replaced:

- Cases 3a and 3c – 216-Z-1, 2, 3, and Z-1A
- Cases 3d and 3e – 216-Z-1, 2, 3, Z-1A, and Z-18

The potential cost savings from the overlap in the amount of overburden to be excavated, stockpiled, and replaced at these sites was not quantified because it was expected to be less than the +50 percent to -30 percent accuracy of the cost estimates.

D3.7.3.1 216-Z-9 Trench Cover Removal

Before the start of the demolition and removal work at the site, it is assumed that all existing structures on the top of the trench cover have been removed. The holes in the concrete cover have been covered and the temporary cover support steel will still be in place.

The cover-removal process is based on removing the concrete cover in sections. The surface of the trench below the cover will be sprayed with a soil fixative that will help control dust from the trench floor during cover removal. The cover will be saw-cut into manageable sections (about 4.5 × 4.5 m [15 × 15 ft]) and lifted out of the waste site with a crane. Each removed section will be saw-cut to fit onto standard highway transport trailers and for easier handling at ERDF. The cover support columns will be saw-cut near the soil line at the base and lifted out by the crane. Each cover section and column will be wrapped in plastic before being placed on a trailer. The remaining lower column sections, column footings, and perimeter stem wall will be demolished, then mixed and removed with the surrounding soil to be hauled to ERDF.

The excavation, sampling, backfilling, and restoration process will follow the typical RTD process.

D3.7.3.2 241-Z-361 and 241-Z-8 Settling Tanks–Retrieve, Treat Sludge, Backfill, and Dispose

As discussed in Section D2.4, DOE/RL-2003-52 was prepared in 2003 for the 241-Z-361 Settling Tank and updated to reflect current costs and include additional scope for backfill and sludge disposal costs to WIPP. The removal action includes only the removal of the sludge, not the tank itself.

The 241-Z-361 Settling Tank will be accessed by removing the top 0.6 m (2 ft) of cover and opening a 8.5 m (28 ft) long by 4.6 m (15 ft) wide excavation. The 241-Z-8 Settling Tank will require removal of the top 1.8 m (6 ft) of clean overburden. The 241-Z-8 excavation area will be 17.7 m (58 ft) long by 7.9 m (26 ft) wide.

Note: An overall adjustment factor of 55 percent was used to address significant uncertainties associated with labor and equipment, inflation, and escalation.

The scope outline of this previous estimate includes the following:

- Procurement
  - Procurement(s)
  - Specification (AEA Technology fluidics equipment)
  - Contract(s)
  - Acceptance test procedure

- Tank Opening
  - Work package preparation and approval
  - Set up area and equipment
  - Cut and remove concrete pad sections
  - Open 241-Z-361 Settling Tank and install in-tank equipment
- Prepare and perform first readiness assessment
  - Prepare equipment for operation
  - Work Package preparation and approval
  - Stage equipment
  - Complete assembly
  - Prepare and perform second readiness assessment
  - Power-up the equipment
- Tank mixing and retrieval
  - Work Package preparation and approval
  - Operations
  - Ship SWBs to CWC
- Demobilize
  - Work Package preparation and approval
  - Dispose of contaminated equipment
  - Prepare and perform third readiness assessment
  - Pull in-tank equipment
- Backfill tank and clean area (CHPRC activity under a work order)
  - Prepare Work Package
  - Backfill and cover tank

The scope for the additional work includes the following:

- Survey
- Sampling analysis
- Transport to WIPP
- Documentation
- CDF backfill of tank
- Project management
- Construction management
- Project closeout

Note: This capital cost was added to the previous DOE/RL-2003-52 cost estimate to represent the full scope of RTD to WIPP.

A temporary tent structure will be constructed over the tank to help control contamination during the retrieval process. The structure will be large enough to house the retrieval system, waste container packaging equipment, and personnel. The waste container used for the sludge containing transuranic radionuclides will be a 1.15 m^3 (1.5-yd^3) SWB that is accepted at WIPP for disposal. The handling of the SWB for WIPP is as described in Section D3.7.2.2.

The SWB is selected as the container of choice to minimize container handling and the total space needed for equipment, containers, and materials near Tank Z-361 and Z-8. SWBs are assumed to cost $4,000 each. Containers should be lined in order to preclude corrosion of the package.

It is assumed that a total of 149 SWBs will be sent to CWC for TRU Waste Packaging and then sent to WIPP for disposal. The 149 SWBs comes from the following calculations:

According to previous reports, Tank Z-8 contains approximately 1,890 L of liquid sludge. It is assumed that an inert sorbent solid will be added to the liquid to stabilize and solidify at a rate of 1 parts liquid to 2 parts sorbent. Therefore, 1,890 L = 5,670 L (1,890 L × 3) = 7.42 yd^3. Each SWB can hold 1.25 yd^3 and, therefore, 7.42/1.25 = ~6 SWBs.

Tank Z-361 contains liquid and sludge layers. According to past reports the liquid layer is equal to approximately 800L = 2,400 L to be placed into SWBs (800 × 3) = 3.14 yd^3 = 3 SWBs. The quantity of sludge in the Z-361 tank is believed to be approximately 76,000 L. Using the AEA Fluidic System (NuVision), it is assumed that there will be approximately 25 percent liquid or quantity added to the sludge in the process of extracting it from the tank. Therefore, 76,000 L = 133,000 L (76,000 L × 1.75) = 173.96 yd^3/1.25 yd^3 (SWB) = 140 SWBs. Using these assumptions, it is assumed that the total for both tanks liquid and sludge is approximate 150 SWBs. The quantity of liquid and sludge from both tanks used to estimate the number of SWBs could be higher by a factor of 50 to 55 percent.

Final tank disposition will be to backfill the tank. It is estimated that 153 m^3 (200 yd^3) of additional backfill will be needed to backfill 241-Z-361 Settling Tank and 57 m^3 (75 yd^3) additional backfill will be needed to backfill 241-Z-8. The tank will be pumped full of CDF to stabilize it. The existing waste site will not require any additional compaction, structure demolition, or waste removal before the start of pumping operations. A concrete pump will be set up near the tank. The existing openings in the tank will be used as pump access points for this work. No new holes will be cut into the tank. An offsite source will be used for making the CDF, which will be hauled to the site by the supplier's trucks. A cure time of 1 week is allowed. Table D-28 presents the capital costs associated with the settling tanks.

It is estimated that 250 days will be required to complete the 241-Z-361 Settling Tank project and 125 days to complete the 241-Z-8 Settling Tank project.

D4.0 References

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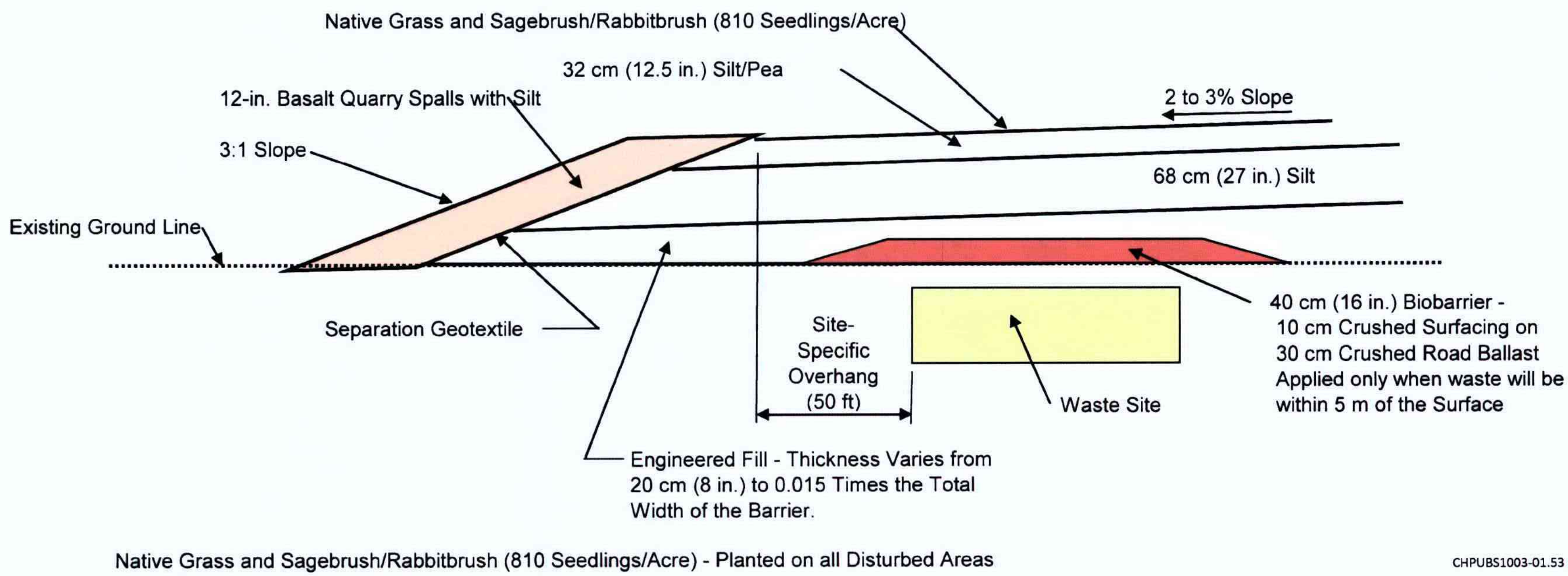

Figure D-1. ET Monofill Barrier

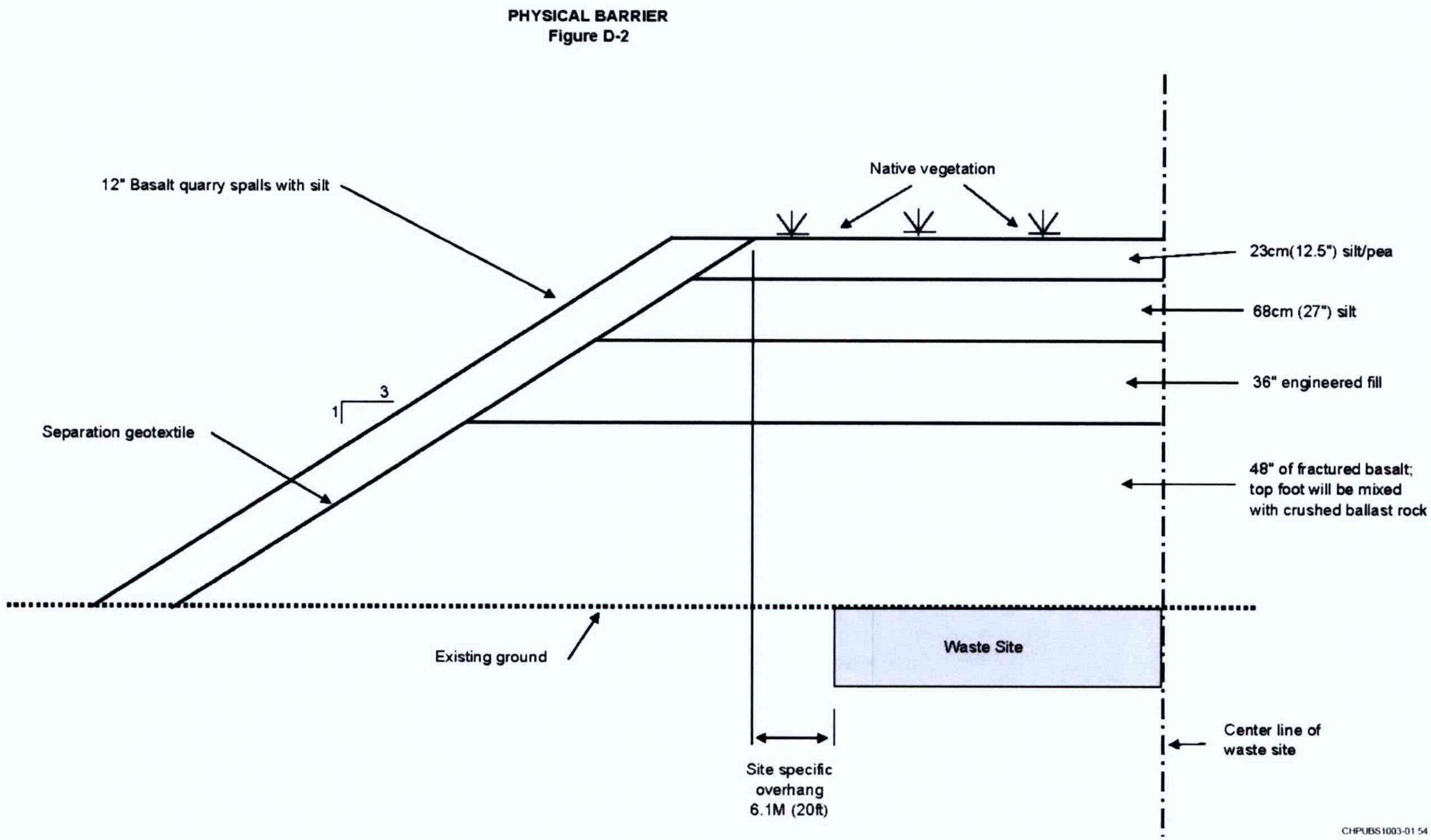

Figure D-2. Physical Barrier

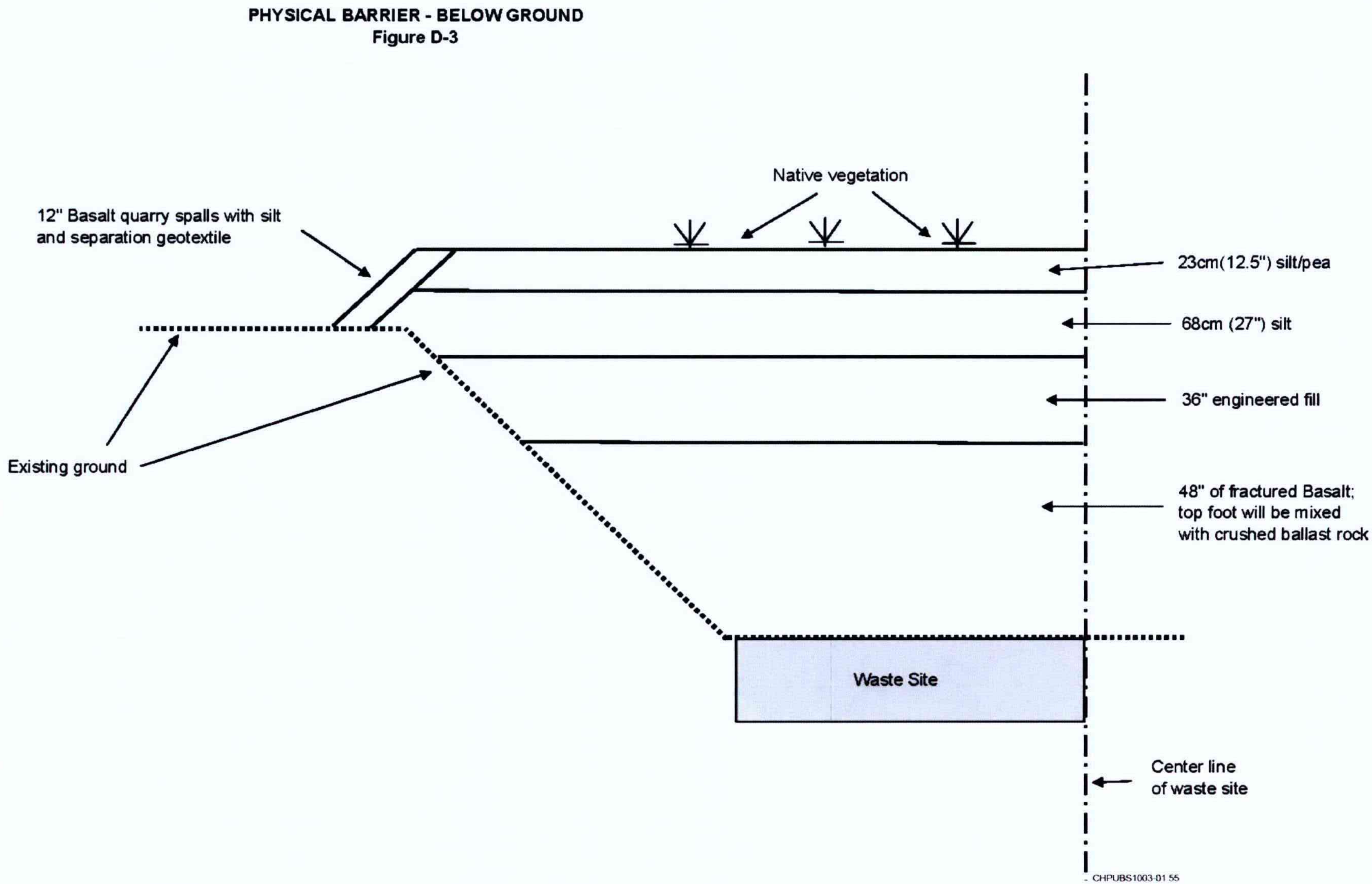

Figure D-3. Physical Barrier–Below Ground

Table D-1. Site Information 200-PW-1 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Site Dimensions (ft) Length (Bottom) (ft)	Site Dimensions (ft) Width (Bottom) (ft)	Site Dimensions (ft) Clean Soil Depth (bgs)	Site Dimensions (ft) Surface Area (Ac)	Engineered Barrier – Capping Dimensions Length (ft)	Engineered Barrier – Capping Dimensions Width (ft)	Engineered Barrier – Acres of Capping	Engineered Barrier – Engineered Fill (yd^3)	Engineered Barrier – Silt Fill (yd^3)	Engineered Barrier – CDF Fill (yd^3)	Engineered Barrier – Basalt (yd^3)	Engineered Barrier – Cap Type	Duration (days)
216-Z-1A	Tile Field	1	Physical Barrier – Below Ground	100	260	8	0.60	305	155	1.1	4,470	5,701	N/A	4,858	ETBB Barrier	41
216-Z-1[a]	Crib	1	Physical Barrier with CDF Backfill	14	14	7	0.004	249	184	1.05	4,235	3,033	58	6,801	ETBB Barrier	42
216-Z-2[a]	Crib	1	Physical Barrier with CDF Backfill	14	14	7	0.004						58		ETBB Barrier	
216-Z-3[a]	Crib	1	Physical Barrier with CDF Backfill	70	5	4	0.01						35		ETBB Barrier	
216-Z-9	Trench	1	ET Monofill Barrier with CDF Backfill	60	30	20	0.04	133	103	0.3	5,151	1,249	N/A	141	ET Monofill	37
216-Z-12	Crib	1	Physical Barrier	200	20	16	0.09	309	129	0.92	3,483	3,242	N/A	5,823	ETBB Barrier	40
216-Z-18	Crib	1	Physical Barrier	207	185	16	0.88	316	294	2.13	9,519	9,719	N/A	14,077	ETBB Barrier	58
241-Z-361	Tank	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a]One Physical Barrier covers 216-Z-1, 216-Z-2, and 216-Z-3; barrier quantities listed for 216-Z-1 are for the total barrier.

Table D-2. Site Information 200-PW-1 Alternative 2

Waste Site	Site Description	Alternative	Alternative Description	Site Dimensions (ft) Length (Bottom) (ft)	Site Dimensions (ft) Width (Bottom) (ft)	Site Dimensions (ft) Clean Soil Depth (bgs)	Site Dimensions (ft) Surface Area (Ac)	ISV – Excavation Dimensions (ft) Length (Top) (ft)	ISV – Excavation Dimensions (ft) Width (Top) (ft)	ISV – Excavation Dimensions (ft) Excavation Depth (ft)	ISV – Excavation Dimensions (ft) Clean Overburden Depth (ft)	ISV – Contam. Soil & Debris Volume (yd^3)	ISV – Overburden Soil Volume (yd^3)	ISV – Additional Fill from Pit 30 (yd^3)	ISV – ISV Melt (Tons)	Duration (days)
216-Z-1A	Tile Field	2	ISV with Backfill	260	100	8	0.60	260	100	0	0	0	0	9,070	18,144	346
216-Z-1	Crib	2	ISV with RTD	14	14	7	0.004	35	35	21	7	50	153	64	118	177
216-Z-2	Crib	2	ISV with RTD	14	14	7	0.004	35	35	21	7	50	153	64	118	177
216-Z-3	Crib	2	ISV with RTD	70	5	4	0.01	97	32	29	4	75	510	35	432	195
216-Z-9	Trench	2	ISV with roof removal and backfill	60	30	20	0.04	60	30	0	0	378	0	5,630	2,160	224
216-Z-12	Crib	2	ISV with RTD	200	20	16	0.09	205	65	16	16	0	4,590	0	1,944	203
216-Z-18	Crib	2	ISV with RTD	207	185	16	0.88	255	233	16	16	0	23,680	0	9,657	470
241-Z-361	Tank	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Table D-3. Site Information 200-PW-1 Alternative 3

OU 200-PW-1, Hanford Site, Richland, Washington.																										
				RTD															Engineered Barrier							
				Site Dimensions (ft)					Excavation Dimensions (ft)										Capping Dimensions (ft)							
Waste Site	Site Description	Option	Description	Length (Bottom) (ft)	Width (Bottom) (ft)	Clean Soil Depth (bgs)	Side Slope (assumed)	Surface Area (Ac)	Length (Top) (ft)	Width (Top) (ft)	Excavation Depth (ft)	Clean Overburden Depth (ft)	Contam. Soil Volume (yd^3)	TRU Contam. Soil Volume (yd^3)	Excav. Vol. (yd^3)	Overburden Soil Volume (yd^3)	Additional Fill (yd^3)	Backfill from Pit 30 (yd^3)	Length (ft)	Width (ft)	Acres of Capping	Engineered Fill (yd^3)	Silt Fill (yd^3)	Basalt (yd^3)	Cap Type	Duration (days)
216-Z-1A	Tile Field	a	RTD with TRU Waste & Barrier	260	23	8	1.5	0.14	304	64	21	8	2701	443	3159	15	15247	18391	339	179	1.4	19559	6179	393	ET Monofill	90
216-Z-1A	Tile Field	b	RTD with TRU Waste & Barrier	260	23	8	1.5	0.14	304	71	24	8	5825	1108	7143	210	15247	22180	339	179	1.4	19559	6179	393	ET Monofill	130
216-Z-1A	Tile Field	c	RTD with TRU Waste & Barrier	260	23	8	step slope	0.14	402	144	37	8	20353	3987	40632	16292	15247	39587	339	179	1.4	19559	6179	393	ET Monofill	311
216-Z-1A	Tile Field	d	RTD with TRU Waste & Barrier	260	23	8	step slope	0.14	684	424	104	8	86389	5316	1595553	1503848	15247	106952	339	179	1.4	19559	6179	393	ET Monofill	522
216-Z-1A	Tile Field	e	RTD with TRU Waste & Barrier	260	23	8	step slope	0.14	533	391	91	8	73871	5316	1298457	1219270	15247	94434	339	179	1.4	19559	6179	393	ET Monofill	489
216-Z-1	Crib	a	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	83	83	23	7	51	65	3018	2902	0	116	85	85	0.17	188	577	95	ET Monofill	48
216-Z-1	Crib	c	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	89	89	25	7	51	80	3758	3627	0	131	85	85	0.17	188	577	95	ET Monofill	48
216-Z-1	Crib	d	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	89	89	25	7	51	80	3758	3627	0	131	85	85	0.17	188	577	95	ET Monofill	48
216-Z-1	Crib	e	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	89	89	25	7	51	80	3758	3627	0	131	85	85	0.17	188	577	95	ET Monofill	48
216-Z-2	Crib	a	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	83	83	23	7	51	65	3018	2902	0	116	85	85	0.17	188	577	95	ET Monofill	48
216-Z-2	Crib	c	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	89	89	25	7	51	80	3758	3627	0	131	85	85	0.17	188	577	95	ET Monofill	48
216-Z-2	Crib	d	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	89	89	25	7	51	80	3758	3627	0	131	85	85	0.17	188	577	95	ET Monofill	48
216-Z-2	Crib	e	RTD with TRU Waste & Barrier	14	14	7	1.5	0.004	89	89	25	7	51	80	3758	3627	0	131	85	85	0.17	188	577	95	ET Monofill	48
216-Z-3	Crib	a	RTD with TRU Waste & Barrier	70	5	4	1.5	0.01	163	98	31	4	162	188	9371	9021	0	350	141	76	0.25	269	951	121	ET Monofill	60
216-Z-3	Crib	c	RTD with TRU Waste & Barrier	70	5	4	1.5	0.01	169	104	33	4	162	214	10955	10579	0	376	141	76	0.25	269	951	121	ET Monofill	63
216-Z-3	Crib	d	RTD with TRU Waste & Barrier	70	5	4	1.5	0.01	169	104	33	4	162	214	10955	10579	0	376	141	76	0.25	269	951	121	ET Monofill	63
216-Z-3	Crib	e	RTD with TRU Waste & Barrier	70	5	4	1.5	0.01	169	104	33	4	162	214	10955	10579	0	376	141	76	0.25	269	951	121	ET Monofill	63
216-Z-9	Trench w/roof	a	RTD with TRU Waste & Barrier	60	30	20	1.5	0.04	129	99	23	20	504	267	4712	3941	4670	4937	133	103	0.3	5151	1217	141	ET Monofill	91
216-Z-9	Trench w/roof	c	RTD with TRU Waste & Barrier	60	30	20	1.5	0.04	168	138	36	20	504	1000	35421	33917	4670	5670	133	103	0.3	5151	1217	141	ET Monofill	136
216-Z-9	Trench w/roof	d	RTD with TRU Waste	60	30	20	step slope	0.04	640	610	120	20	5970	1134	2276665	2269561	4670	10136	0	0	0	0	0	0	N/A	221
216-Z-9	Trench w/roof	e	RTD with TRU Waste & Barrier	60	30	20	step slope	0.04	530	500	90	20	4037	1067	1454939	1449835	4670	8203	133	103	0.3	5151	1217	141	ET Monofill	186
216-Z-12	Crib	a	RTD with TRU Waste & Barrier	200	20	16	1.5	0.09	266	86	22	16	296	593	10950	10061	0	889	272	92	0.57	795	2496	215	ET Monofill	74
216-Z-12	Crib	c	RTD with TRU Waste & Barrier	200	20	16	1.5	0.09	272	92	24	16	296	889	12899	11714	0	1185	272	92	0.57	795	2496	215	ET Monofill	86
216-Z-12	Crib	d	RTD with TRU Waste & Barrier	200	20	16	1.5	0.09	272	92	24	16	296	889	12899	11714	0	1185	272	92	0.57	795	2496	215	ET Monofill	86
216-Z-12	Crib	e	RTD with TRU Waste & Barrier	200	20	16	1.5	0.09	272	92	24	16	296	889	12899	11714	0	1185	272	92	0.57	795	2496	215	ET Monofill	86
216-Z-18	Crib	a	RTD with TRU Waste & Barrier	207	185	16	1.5	0.88	267	245	20	16	307	920	38412	37185	0	1227	294	272	1.84	9386	8254	524	ET Monofill	141
216-Z-18	Crib	c	RTD with TRU Waste & Barrier	207	185	16	step slope	0.88	360	338	36	16	22540	5827	336150	307783	0	28367	294	272	1.84	9386	8254	524	ET Monofill	296
216-Z-18	Crib	d	RTD with TRU Waste & Barrier	207	185	16	step slope	0.88	736	714	103	16	115727	7668	2259380	2135985	0	123395	294	272	1.84	9386	8254	524	ET Monofill	562
216-Z-18	Crib	e	RTD with TRU Waste & Barrier	207	185	16	step slope	0.88	677	655	90	16	97289	7668	1829326	1724369	0	104957	294	272	1.84	9386	8254	524	ET Monofill	515

Table D-4. Site Information 200-PW-3 Alternative 1

				Site Dimensions (ft)				Engineered Barrier							
								Capping Dimensions							
Waste Site	Site Description	Alternative	Alternative Description	Length (Bottom) (ft)	Width (Bottom) (ft)	Clean Soil Depth (bgs)	Surface Area (Ac)	Length (ft)	Width (ft)	Acres of Capping	Engineered Fill (yd^3)	Silt Fill (yd^3)	Basalt (yd^3)	Cap Type	Duration (days)
216-A-7	Crib	1	ET Monofill Barrier w/ BioBarrier	10	10	9	0.002	89	89	0.18	417	608	124	ET Monofill	35
216-A-8	Crib	1	ET Monofill Barrier w/ BioBarrier	20	250	12	0.115	330	100	0.76	1,815	3,246	330	ET Monofill	36
216-A-24	Crib	1	ET Monofill Barrier w/ BioBarrier	20	700	9	0.321	780	100	1.79	4,275	8,032	694	ET Monofill	42
216-A-31	Crib	1	ET Monofill Barrier	10	70	20	0.016	141	81	0.26	290	1,038	124	ET Monofill	34
UPR-200-E-56	Unplanned Release	1	ET Monofill Barrier w/ BioBarrier	110	430	0	1.086	518	198	2.35	9,338	11,147	691	ET Monofill	48

Table D-5. Site Information 200-PW-3 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	Remove, Treat, and Dispose														Engineered Barrier							Duration (days)
				Site Dimensions (ft)					Excavation Dimensions (ft)								Capping Dimensions							
				Length (Bottom) (ft)	Width (Bottom) (ft)	Clean Soil Depth (bgs)	Side Slope (assumed)	Surface Area (Ac)	Length (Top) (ft)	Width (Top) (ft)	Excavation Depth (ft)	Clean Overburden Depth (ft)	Contam. Soil Volume (yd^3)	Excav. Vol. (yd^3)	Overburden Soil Volume (yd^3)	Backfill from Pit 30 (yd^3)	Length (ft)	Width (ft)	Acres of Capping	Engineered Fill (yd^3)	Silt Fill (yd^3)	Basalt (yd^3)	Cap Type	
216-A-7	Crib	3b	RTD(w/mixing) & ET Monofill Barrier	10	10	9	1.5	0.002	55	55	15	9	22	868	846	22	81	81	0.2	156	522	89	ET Monofill	39
216-A-7	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	10	10	9	1.5	0.002	70	70	20	9	41	1852	1811	41	81	81	0.2	156	522	89	ET Monofill	42
216-A-8	Crib	3b	RTD(w/mixing) & ET Monofill Barrier	20	250	12	1.5	0.115	65	295	15	12	556	6715	6160	556	322	92	0.7	947	2995	246	ET Monofill	50
216-A-8	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	20	250	12	1.5	0.115	89	319	23	12	2037	14222	12185	2037	322	92	0.7	947	2995	246	ET Monofill	74
216-A-24	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	20	700	9	1.5	0.321	80	760	20	9	5704	27704	22000	5704	722	92	1.5	2323	7481	522	ET Monofill	121
UPR-200-E-56	Unplanned Release	3b	RTD	110	430	0	1.5	1.086	155	475	15	0	26278	33590	7313	26278	N/A	N/A	N/A	N/A	N/A	N/A	N/A	136
UPR-200-E-56	Unplanned Release	3c	RTD	110	430	0	1.5	1.086	170	490	20	0	35037	48370	13333	35037	N/A	N/A	N/A	N/A	N/A	N/A	N/A	179

Table D-6. Site Information 200-PW-6 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Engineered Barrier														Duration (days)
				Site Dimensions (ft)					Capping Dimensions (ft)									
				Length (Bottom) (ft)	Width (Bottom) (ft)	Clean Soil Depth (bgs)	Side Slope (assumed)	Surface Area (Ac)	Length (ft)	Width (ft)	Acres of Capping	Engineered Fill (yd^3)	Silt Fill (yd^3)	CDF Fill (yd^3)	Basalt (yd^3)	Cap Type		
216-Z-5	Two Cribs	1	Physical Barrier w/CDF Backfill	84	14	14	1.5	0.027	193	123	0.5	2,059	1,854	65	4,335	ET BB		41
216-Z-8	French Drain	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
216-Z-10	Well	1	Decommission	10	10	150	N/A	0.002	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Grout		5
241-Z-10	Tank	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A

Table D-7. Site Information 200-PW-6 Alternative 2

Waste Site	Site Description	Alternative	Alternative Description	ISV													Duration (days)
				Site Dimensions (ft)				Excavation Dimensions (ft)									
				Length (Bottom) (ft)	Width (Bottom) (ft)	Clean Soil Depth (bgs)	Surface Area (Ac)	Length (Top) (ft)	Width (Top) (ft)	Excavation Depth (ft)	Clean Overburden Depth (ft)	Contam. Soil and Debris Volume (yd^3)	Overburden Soil Volume (yd^3)	Additional Fill from Pit 30 (yd^3)	ISV Melt (Tons)		
216-Z-5	Crib – two	2	ISV with RTD	83	18	9	0.034	120	60	18	9	20	2,340	58	235		183
216-Z-8	French Drain	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
216-Z-10	Well	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A
241-Z-8	Tank	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A

Table D-8. Site Information 200-PW-6 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	RTD															Engineered Barrier							Duration (days)
				Site Dimensions (ft)					Excavation Dimensions (ft)										Capping Dimensions							
				Length (Bottom) (ft)	Width (Bottom) (ft)	Clean Soil Depth (bgs)	Side Slope (assumed)	Surface Area (Ac)	Length (Top) (ft)	Width (Top) (ft)	Excavation Depth (ft)	Clean Overburden Depth (ft)	Contam. Soil Volume (yd^3)	TRU Contam. Soil Volume (yd^3)	Excav. Vol. (yd^3)	Overburden Soil Volume (yd^3)	Additional Fill (yd^3)	Backfill from Pit 30 (yd^3)	Length (ft)	Width (ft)	Acres of Capping	Engineered Fill (yd^3)	Silt Fill (yd^3)	Basalt (yd^3)	Cap Type	
216-Z-5	Two Cribs	3a	RTD with TRU Waste and ET Monofill Barrier	14	14	14	1.5	0.004	74	74	20	14	15	30	2,101	2,056	0	45	85	85	0.17	188	591	95	ET Monofill	43
216-Z-5	Two Cribs	3c	RTD with TRU Waste and ET Monofill Barrier	14	14	14	1.5	0.004	83	83	23	14	15	52	3,018	2,951	0	67	85	85	0.17	188	591	95	ET Monofill	45
216-Z-5	Two Cribs	3d	RTD with TRU Waste and ET Monofill Barrier	14	14	14	1.5	0.004	83	83	23	14	15	52	3,018	2,951	0	67	85	85	0.17	188	591	95	ET Monofill	45
216-Z-5	Two Cribs	3e	RTD with TRU Waste and ET Monofill Barrier	14	14	14	1.5	0.004	83	83	23	14	15	52	3,018	2,951	0	67	85	85	0.17	188	591	95	ET Monofill	45
216-Z-8	French Drain	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
216-Z-10	Well	N/A	No Action	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table D-9A. Capital Cost 200-PW-1 Alternative 1

Site	Description	Opt	Alternative	Mobilization/ Demobilization	Monitoring & Sampling	Site Work	Soil Excavation & Treatment	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-Z-1A	Tile Field	N/A	Physical Barrier - Bleow Ground	$142,321	$3,444	$19,661	$0	$534,467	$159,950	$85,616	$945,459	$236,365	$141,819	$1,323,643
216-Z-1	Crib	N/A	Physical Barrier with CDF Backfill	$47,329	$1,148	$6,554	$0	$220,155	$54,530	$29,207	$358,923	$89,731	$67,298	$515,951
216-Z-2	Crib	N/A	Physical Barrier with CDF Backfill	$47,329	$1,148	$6,554	$0	$220,155	$54,530	$29,207	$358,923	$89,731	$67,298	$515,951
216-Z-3	Crib	N/A	Physical Barrier with CDF Backfill	$47,329	$1,148	$6,554	$0	$220,155	$54,530	$29,207	$358,923	$89,731	$67,298	$515,951
216-Z-9	Trench	N/A	ET Monofill Barrier with CDF Backfill	$265,526	$3,214	$24,671	$0	$536,094	$127,980	$79,295	$1,036,780	$259,195	$155,517	$1,451,492
216-Z-12	Crib	N/A	Physical Barrier	$264,283	$3,444	$19,661	$0	$534,529	$156,310	$83,159	$1,061,386	$265,347	$159,208	$1,485,940
216-Z-18	Crib	N/A	Physical Barrier	$272,051	$3,444	$29,491	$0	$1,297,259	$221,839	$120,142	$1,944,226	$486,057	$194,423	$2,624,705
241-Z-361	Tank	N/A	N/A											

Table D-9B. Capital Cost 200-PW-1 Alternative 1 SVE Installation

Site	Description	Opt	Alternative	Well Drilling	Equipment Installation	Project Management	Subtotal	Contingency (25%)	Total Project
216-Z-1A	Tile Field	a, b, c, d, and e	Alternative 1 – SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-2	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-3	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-9	Trench	a	Alternative 1 – SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-12	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-18	Crib	a	Alternative 1 – SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0	$0	$0

Table D-9C. Capital Cost 200-PW-1 Alternative 1 SVE Remove

Site	Description	Opt	Alternative	Well D&D	Project Management	Subtotal	Contingency (25%)	Total Project
216-Z-1A	Tile Field	a, b, c, d, and e	Alternative 1 – SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-2	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-3	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-9	Trench	a	Alternative 1 – SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-12	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-18	Crib	a	Alternative 1 – SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0	$0

Table D-10A. Capital Cost 200-PW-1 Alternative 2

Site	Description	Opt	Alternative	Mobilization/ Demobilization	Monitoring & Sampling	Site Work	Soil Excavation & Treatment	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-Z-1A	Tile Field	N/A	Alternative 2 - ISV with Backfill	$556,292	$11,756	$250,727	$42,937,765	$0	$201,593	$1,031,605	$44,989,738	$11,247,435	$3,374,230	$59,611,403
216-Z-1	Crib	N/A	Alternative 2 - ISV with RTD	$510,052	$21,001	$53,485	$323,924	$0	$172,223	$412,597	$1,493,282	$373,321	$223,992	$2,090,595
216-Z-2	Crib	N/A	Alternative 2 - ISV with RTD	$510,052	$21,001	$53,485	$323,924	$0	$172,223	$412,597	$1,493,282	$373,321	$223,992	$2,090,595
216-Z-3	Crib	N/A	Alternative 2 - ISV with RTD	$515,825	$22,663	$58,667	$1,178,711	$0	$172,223	$440,022	$2,388,111	$597,028	$238,811	$3,223,950
216-Z-9	Trench	N/A	Alternative 2 - ISV with roof removal & backfill	$2,041,928	$11,263	$131,138	$5,426,714	$0	$308,059	$482,078	$8,401,180	$2,100,295	$630,089	$11,131,564
216-Z-12	Crib	N/A	Alternative 2 - ISV with RTD	$1,888,732	$21,186	$96,362	$4,705,075	$0	$197,922	$457,745	$7,367,022	$1,841,756	$736,702	$9,945,480
216-Z-18	Crib	N/A	Alternative 2 - ISV with RTD	$1,960,376	$27,833	$280,821	$24,217,149	$0	$326,415	$1,462,309	$28,274,903	$7,068,726	$2,120,618	$37,464,246
241-Z-361	Tank	N/A	N/A											

Table D-10B. Capital Cost 200-PW-1 Alternative 2 SVE Installation

Site	Description	Opt	Alternative	Well Drilling	Equipment Installation	Project Management	Subtotal	Contingency (25%)	Total Project
216-Z-1A	Tile Field	a, b, c, d, and e	Alternative 2 – SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-2	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-3	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-9	Trench	a	Alternative 2 – SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-12	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-18	Crib	a	Alternative 2 – SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0	$0	$0

Table D-10C. Capital Cost 200-PW-1 Alternative 2 SVE Remove

Site	Description	Opt	Alternative	Well D&D	Project Management	Subtotal	Contingency (25%)	Total Project
216-Z-1A	Tile Field	a, b, c, d, and e	Alternative 2 – SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-2	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-3	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-9	Trench	a	Alternative 2 – SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-12	Crib	a	N/A	$0	$0	$0	$0	$0
216-Z-18	Crib	a	Alternative 2 – SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0	$0

Table D-11A. Capital Cost 200-PW-1 Alternative 3

Site	Description	Opt	Alternative	Mobilization/ Demobilization	Monitoring & Sampling	Site Work	Soil Excavation & Treatment	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-Z-1A	Tile Field	a	Alternative 3 - RTD with TRU Waste & Barrier	$619,085	$1,212,037	$56,377	$8,088,332	$411,467	$279,274	$167,960	$10,834,532	$2,708,633	$812,590	$14,355,755
216-Z-1A	Tile Field	b	Alternative 3 - RTD with TRU Waste & Barrier	$623,936	$1,218,001	$98,066	$19,561,975	$411,467	$413,003	$242,609	$22,569,057	$5,642,264	$1,692,679	$29,904,001
216-Z-1A	Tile Field	c	Alternative 3 - RTD with TRU Waste & Barrier	$1,293,537	$1,828,587	$104,277	$69,072,811	$411,467	$2,270,299	$615,155	$75,596,133	$18,899,033	$5,669,710	$100,164,876
216-Z-1A	Tile Field	d	Alternative 3 - RTD with TRU Waste & Barrier	$1,351,959	$2,689,388	$5,436,559	$104,357,731	$411,467	$3,998,607	$1,035,529	$119,281,240	$29,820,310	$8,946,093	$158,047,643
216-Z-1A	Tile Field	e	Alternative 3 - RTD with TRU Waste & Barrier	$1,341,664	$2,604,394	$4,465,645	$102,485,753	$411,467	$3,728,303	$969,783	$116,007,009	$29,001,752	$8,700,526	$153,709,287
216-Z-1	Crib	a	Alternative 3 - RTD with TRU Waste & Barrier	$231,983	$245,484	$52,323	$1,485,371	$36,737	$145,330	$86,760	$2,283,988	$570,997	$228,399	$3,083,384
216-Z-1	Crib	c,d, & e	Alternative 3 - RTD with TRU Waste & Barrier	$246,826	$245,484	$57,286	$1,489,359	$36,737	$152,166	$90,493	$2,318,351	$579,588	$231,835	$3,129,774
216-Z-2	Crib	a	Alternative 3 - RTD with TRU Waste & Barrier	$231,983	$245,484	$52,323	$1,485,371	$36,737	$145,330	$86,760	$2,283,988	$570,997	$228,399	$3,083,384
216-Z-2	Crib	c,d, & e	Alternative 3 - RTD with TRU Waste & Barrier	$246,826	$245,484	$57,286	$1,489,359	$36,737	$152,166	$90,493	$2,318,351	$579,588	$231,835	$3,129,774
216-Z-3	Crib	a	Alternative 3 - RTD with TRU Waste & Barrier	$365,822	$293,159	$103,767	$3,541,550	$43,815	$196,603	$114,754	$4,659,470	$1,164,868	$465,947	$6,290,285
216-Z-3	Crib	c,d, & e	Alternative 3 - RTD with TRU Waste & Barrier	$371,564	$307,871	$114,426	$4,007,491	$43,815	$206,858	$120,352	$5,172,377	$1,293,094	$517,238	$6,982,709
216-Z-9	Trench	a	Alternative 3 - RTD with TRU Waste & Barrier	$974,001	$323,130	$120,989	$5,139,468	$115,311	$1,360,102	$183,039	$8,216,040	$2,054,010	$616,203	$10,886,253
216-Z-9	Trench	c	Alternative 3 - RTD with TRU Waste & Barrier	$869,742	$593,555	$306,378	$17,394,452	$108,796	$479,743	$259,062	$20,011,728	$5,002,932	$1,500,880	$26,515,540
216-Z-9	Trench	d	Alternative 3 - RTD with TRU Waste	$1,179,884	$1,722,467	$7,150,026	$26,289,759	$0	$1,661,011	$443,078	$38,446,225	$9,611,556	$2,883,467	$50,941,248
216-Z-9	Trench	e	Alternative 3 - RTD with TRU Waste & Barrier	$1,156,876	$934,546	$4,653,349	$24,268,360	$108,796	$1,310,748	$371,835	$32,804,510	$8,201,128	$2,460,338	$43,465,976
216-Z-12	Crib	a	Alternative 3 - RTD with TRU Waste & Barrier	$816,923	$447,357	$143,123	$10,189,513	$77,002	$244,459	$140,881	$12,059,258	$3,014,815	$904,444	$15,978,517
216-Z-12	Crib	c,d, & e	Alternative 3 - RTD with TRU Waste & Barrier	$844,342	$557,418	$133,818	$15,037,409	$77,002	$285,478	$163,276	$17,098,743	$4,274,686	$1,282,406	$22,655,834
216-Z-18	Crib	a	Alternative 3 - RTD with TRU Waste & Barrier	$1,278,563	$629,414	$336,424	$15,827,136	$293,822	$468,228	$265,918	$19,099,505	$4,774,876	$1,432,463	$25,306,844
216-Z-18	Crib	c	Alternative 3 - RTD with TRU Waste & Barrier	$1,806,059	$2,579,626	$1,191,734	$100,682,575	$293,822	$2,209,786	$589,311	$109,352,913	$27,338,228	$8,201,468	$144,892,610
216-Z-18	Crib	d	Alternative 3 - RTD with TRU Waste & Barrier	$1,981,508	$4,048,329	$8,320,584	$149,937,505	$293,822	$4,703,284	$1,195,815	$170,480,847	$42,620,212	$12,786,064	$225,887,122
216-Z-18	Crib	e	Alternative 3 - RTD with TRU Waste & Barrier	$1,961,741	$3,854,906	$6,795,695	$146,525,801	$293,822	$4,289,813	$1,095,247	$164,817,025	$41,204,256	$12,361,277	$218,382,558

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Table D-11B. Capital Cost 200-PW-1 Alternative 3 SVE Installation

Site	Description	Opt	Alternative	Well Drilling	Equipment Installation	Project Management	Sub Total	Contingency (25%)	Total Project
216-Z-1A	Tile Field	a	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1A	Tile Field	b	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1A	Tile Field	c	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1A	Tile Field	d	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1A	Tile Field	e	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-1	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-2	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-3	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-9	Trench	a	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-9	Trench	c	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-9	Trench	d	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-9	Trench	e	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-12	Crib	a	N/A	$0	$0	$0	$0	$0	$0
216-Z-18	Crib	a	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-18	Crib	c	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-18	Crib	d	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
216-Z-18	Crib	e	Alternative 3 - SVE Installation	$1,530,589	$120,129	$42,285	$1,693,003	$423,251	$2,116,254
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0	$0	$0

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Table D-11C. Capital Cost 200-PW-1 Alternative 3 SVE Remove

Waste Site	Site Description	Alternative	Alternative Description	Well D&D	Project Management	Subtotal	Contingency (25%)	Total Project
216-Z-1A	Tile Field	3a	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1A	Tile Field	3b	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1A	Tile Field	3c	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1A	Tile Field	3d	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1A	Tile Field	3e	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-1	Crib	3	N/A	$0	$0	$0	$0	$0
216-Z-2	Crib	3	N/A	$0	$0	$0	$0	$0
216-Z-3	Crib	3	N/A	$0	$0	$0	$0	$0
216-Z-9	Trench	3a	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-9	Trench	3c	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-9	Trench	3d	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-9	Trench	3e	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-12	Crib	3	N/A	$0	$0	$0	$0	$0
216-Z-18	Crib	3a	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-18	Crib	3c	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-18	Crib	3d	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
216-Z-18	Crib	3e	SVE Decommissioning	$108,486	$38,187	$146,673	$36,668	$183,341
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0	$0

Table D-12. Capital Cost 200-PW-3 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Mobilization/ Demobilization	Monitoring and Sampling	Site Work	Soil Excavation	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-A-7	Crib	1	ET Monofill Barrier w/ BioBarrier	$256,999	$3,214	$24,119	$0	$53,520	$110,623	$68,098	$516,573	$129,143	$77,486	$723,203
216-A-8	Crib	1	ET Monofill Barrier w/ BioBarrier	$257,405	$3,214	$34,036	$0	$137,961	$113,516	$69,964	$616,096	$154,024	$92,414	$862,535
216-A-24	Crib	1	ET Monofill Barrier w/ BioBarrier	$265,819	$3,214	$53,354	$0	$294,509	$130,873	$81,583	$829,351	$207,338	$124,403	$1,161,092
216-A-31	Crib	1	ET Monofill Barrier	$257,488	$3,214	$24,538	$0	$45,443	$107,730	$160,743	$599,157	$149,789	$89,874	$838,820
UPR-200-E-56	Unplanned Release	1	ET Monofill Barrier w/ BioBarrier	$268,407	$3,214	$36,758	$0	$474,257	$148,230	$93,201	$1,024,067	$256,017	$153,610	$1,433,694

Adjusted for FY09 G&A Change from 14.3 to 8.5

Table D-13. Capital Cost 200-PW-3 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	Mobilization/ Demobilization	Monitoring & Sampling	Site Work	Soil Excavation	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-A-7	Crib	3b	RTD(w/mixing) & ET Monofill Barrier	$400,711	$175,997	$29,878	$27,276	$34,561	$124,150	$75,141	$867,714	$216,929	$130,157	$1,214,800
216-A-7	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$400,711	$175,997	$36,588	$44,525	$34,561	$131,038	$78,901	$902,322	$225,580	$135,348	$1,263,251
216-A-8	Crib	3b	RTD(w/mixing) & ET Monofill Barrier	$404,321	$175,997	$87,719	$317,813	$86,809	$168,922	$99,585	$1,341,166	$335,292	$201,175	$1,877,632
216-A-8	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$409,214	$180,615	$167,171	$1,043,561	$86,809	$244,690	$140,951	$2,273,012	$568,253	$227,301	$3,068,566
216-A-24	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$426,816	$252,761	$352,535	$2,791,124	$181,827	$404,267	$229,631	$4,638,960	$1,159,740	$463,896	$6,262,597
216-A-31	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$401,373	$176,229	$77,485	$173,705	$45,106	$168,922	$99,585	$1,142,405	$285,601	$171,361	$1,599,367
UPR-200-E-56	Unplanned Release	3b	RTD	$386,518	$271,837	$472,671	$4,228,617	$0	$478,412	$259,793	$6,494,419	$1,623,605	$487,081	$8,605,105
UPR-200-E-56	Unplanned Release	3c	RTD	$396,571	$303,804	$629,262	$5,668,464	$0	$626,503	$340,645	$7,965,249	$1,991,312	$597,394	$10,553,955

Adjusted for FY09 G&A Change from 14.3 to 8.5

Table D-14. Capital Cost 200-PW-6 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Mobilization/ Demobilization	Monitoring and Sampling	Site Work	Soil Excavation	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-Z-5	Two Cribs	1	Physical Barrier w/CDF Backfill	$248,560	$3,255	$18,582	$0	$346,964	$151,172	$80,490	$849,023	$212,256	$127,353	$1,188,632
216-Z-8	French Drain	N/A	N/A	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
216-Z-10	Well	1	Decommission	$45,394	$13,052	$8,143	$16,424	$0	$18,359	$11,335	$112,707	$28,177	$21,133	$162,017
241-Z-8	Tank	N/A	N/A	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Adjusted for FY09 G&A

Table D-15. Capital Cost 200-PW-6 Alternative 2

Waste Site	Site Description	Alternative	Alternative Description	Mobilization/ Demobilization	Monitoring and Sampling	Site Work	Soil Excavation and Treatment	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-Z-5	Two Cribs	2	ISV with RTD	$175,143	$1,955	$6,160	$59,523	$0	$17,060	$35,923	$295,764	$73,941	$29,576	$399,281
216-Z-8	French Drain	N/A	No Action	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
216-Z-10	Well	N/A	No Action	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
241-Z-8	Tank	N/A	No Action	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Adjusted for FY09 G&A

Table D-16. Capital Cost 200-PW-6 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	Mobilization/ Demobilization	Monitoring and Sampling	Site Work	Soil Excavation	Site Improvements	Construction Staff	Project Management	Sub Total	Contingency (25%)	Remedial Design	Total Project
216-Z-5	Two Cribs	3a	RTD with TRU Waste and ET Monofill Barrier	$610,005	$232,404	$43,539	$902,210	$36,335	$137,918	$82,657	$2,045,070	$511,268	$204,507	$2,760,845
216-Z-5	Two Cribs	3c	RTD with TRU Waste and ET Monofill Barrier	$625,724	$235,967	$50,011	$1,025,155	$36,335	$144,804	$86,417	$2,204,415	$551,104	$220,442	$2,975,960
216-Z-5	Two Cribs	3d	RTD with TRU Waste and ET Monofill Barrier	$625,724	$235,967	$50,011	$1,025,155	$36,335	$144,804	$86,417	$2,204,415	$551,104	$220,442	$2,975,960
216-Z-5	Two Cribs	3e	RTD with TRU Waste and ET Monofill Barrier	$625,724	$235,967	$50,011	$1,025,155	$36,335	$144,804	$86,417	$2,204,415	$551,104	$220,442	$2,975,960
216-Z-8	French Drain	N/A	No Action	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
216-Z-10	Well	N/A	No Action	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table D-17. Present Worth Costs 200-PW-1 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Discounted Annual and Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-Z-1A	Tile Field	1	Physical Barrier–Below Ground	$3,623,238	$35,836,349	$39,459,588	$6,015,931
216-Z-1	Crib	1	Physical Barrier with CDF Backfill	$515,951	$33,977,533	$34,493,484	$1,686,671
216-Z-2	Crib	1	Physical Barrier with CDF Backfill	$515,951	$33,977,533	$34,493,484	$1,686,671
216-Z-3	Crib	1	Physical Barrier with CDF Backfill	$515,951	$33,977,533	$34,493,484	$1,686,671
216-Z-9	Trench	1	ET Monofill Barrier with CDF Backfill	$3,751,088	$35,836,349	$39,587,437	$6,110,288
216-Z-12	Crib	1	Physical Barrier	$1,485,940	$33,977,533	$35,463,474	$2,656,660
216-Z-18	Crib	1	Physical Barrier	$4,924,301	$35,836,349	$40,760,650	$6,976,158
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0

Table D-18. Present Worth Costs 200-PW-1 Alternative 2

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Discounted Annual and Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-Z-1A	Tile Field	2	ISV with Backfill	$61,910,998	$35,786,639	$97,697,637	$48,410,918
216-Z-1	Crib	2	ISV with RTD	$2,090,595	$33,977,533	$36,068,128	$3,261,314
216-Z-2	Crib	2	ISV with RTD	$2,090,595	$33,977,533	$36,068,128	$3,261,314
216-Z-3	Crib	2	ISV with RTD	$3,223,950	$33,977,533	$37,201,483	$4,394,669
216-Z-9	Trench	2	ISV with roof removal and backfill	$13,431,159	$35,836,349	$49,267,509	$13,254,499
216-Z-12	Crib	2	ISV with RTD	$9,945,480	$33,977,533	$43,923,013	$11,116,199
216-Z-18	Crib	2	ISV with RTD	$39,763,842	$35,786,639	$75,550,481	$32,288,189
241-Z-361	Tank	N/A	N/A	$0	$0	$0	$0

Table D-19. Present Worth Costs 200-PW-1 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Disounted Annual & Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-Z-1A	Tile Field	3a	RTD with TRU Waste & ET Monofill Barrier	$16,655,351	$35,836,349	$52,491,700	$15,634,059
216-Z-1A	Tile Field	3b	RTD with TRU Waste & ET Monofill Barrier	$32,203,596	$35,836,349	$68,039,946	$27,109,176
216-Z-1A	Tile Field	3c	RTD with TRU Waste & ET Monofill Barrier	$102,464,472	$35,786,639	$138,251,111	$77,933,112
216-Z-1A	Tile Field	3d	RTD with TRU Waste & ET Monofill Barrier	$160,347,239	$2,196,051	$162,543,289	$117,648,760
216-Z-1A	Tile Field	3e	RTD with TRU Waste & ET Monofill Barrier	$156,008,883	$2,196,051	$158,204,933	$116,050,212
216-Z-1	Crib	3a	RTD with TRU Waste & ET Monofill Barrier	$3,083,384	$33,977,533	$37,060,917	$4,254,103
216-Z-1	Crib	3c	RTD with TRU Waste & ET Monofill Barrier	$3,129,774	$0	$3,129,774	$3,129,774
216-Z-1	Crib	3d	RTD with TRU Waste & ET Monofill Barrier	$3,129,774	$0	$3,129,774	$3,129,774
216-Z-1	Crib	3e	RTD with TRU Waste & ET Monofill Barrier	$3,129,774	$0	$3,129,774	$3,129,774
216-Z-2	Crib	3a	RTD with TRU Waste & ET Monofill Barrier	$3,083,384	$33,977,533	$37,060,917	$4,254,103
216-Z-2	Crib	3c	RTD with TRU Waste & ET Monofill Barrier	$3,129,774	$0	$3,129,774	$3,129,774
216-Z-2	Crib	3d	RTD with TRU Waste & ET Monofill Barrier	$3,129,774	$0	$3,129,774	$3,129,774
216-Z-2	Crib	3e	RTD with TRU Waste & ET Monofill Barrier	$3,129,774	$0	$3,129,774	$3,129,774
216-Z-3	Crib	3a	RTD with TRU Waste & ET Monofill Barrier	$6,290,285	$33,977,533	$40,267,818	$7,461,004
216-Z-3	Crib	3c	RTD with TRU Waste & ET Monofill Barrier	$6,982,709	$0	$6,982,709	$6,982,709
216-Z-3	Crib	3d	RTD with TRU Waste & ET Monofill Barrier	$6,982,709	$0	$6,982,709	$6,982,709
216-Z-3	Crib	3e	RTD with TRU Waste & ET Monofill Barrier	$6,982,709	$0	$6,982,709	$6,982,709
216-Z-9	Trench	3a	RTD with TRU Waste & ET Monofill Barrier	$13,185,849	$35,836,349	$49,022,198	$13,073,452
216-Z-9	Trench	3c	RTD with TRU Waste & ET Monofill Barrier	$28,815,135	$35,836,349	$64,651,485	$24,608,380
216-Z-9	Trench	3d	RTD with TRU Waste	$53,240,844	$2,196,051	$55,436,895	$41,748,953
216-Z-9	Trench	3e	RTD with TRU Waste & ET Monofill Barrier	$45,765,571	$2,196,051	$47,961,622	$36,231,956
216-Z-12	Crib	3a	RTD with TRU Waste & ET Monofill Barrier	$15,978,517	$33,977,533	$49,956,050	$17,149,236
216-Z-12	Crib	3c	RTD with TRU Waste & ET Monofill Barrier	$22,655,834	$0	$22,655,834	$22,655,834
216-Z-12	Crib	3d	RTD with TRU Waste & ET Monofill Barrier	$22,655,834	$0	$22,655,834	$22,655,834
216-Z-12	Crib	3e	RTD with TRU Waste & ET Monofill Barrier	$22,655,834	$0	$22,655,834	$22,655,834
216-Z-18	Crib	3a	RTD with TRU Waste & ET Monofill Barrier	$27,606,440	$35,836,349	$63,442,789	$23,716,323
216-Z-18	Crib	3c	RTD with TRU Waste & ET Monofill Barrier	$147,192,205	$35,786,639	$182,978,844	$110,494,092
216-Z-18	Crib	3d	RTD with TRU Waste & ET Monofill Barrier	$228,186,718	$2,196,051	$230,382,769	$166,365,197
216-Z-18	Crib	3e	RTD with TRU Waste & ET Monofill Barrier	$220,682,154	$2,196,051	$222,878,205	$160,976,070

Table D-20. Present Worth Costs 200-PW-1 Summary

Net Present Worth Cost Estimates. (1000 Years)

WASTE SITE/GROUP		No Action	ALTERNATIVE 1: Capping and Institutional Controls	ALTERNATIVE 2: ISV and Institutional Controls	ALTERNATIVE 3A: Remove and Dispose with Capping and Institutional Controls	ALTERNATIVE 3B: Remove and Dispose with Capping and Institutional Controls	ALTERNATIVE 3C: Remove and Dispose with Capping	ALTERNATIVE 3D: Remove and Dispose with Capping	ALTERNATIVE 3E: Remove and Dispose with Capping
216-Z-1A	Present Worth Cost	$0	$6,015,931	$48,410,918	$15,634,059	$27,109,176	$77,933,112	$117,648,760	$116,050,212
	Non-discounted cost	$0	$39,459,588	$97,697,637	$52,491,700	$68,039,946	$138,251,111	$162,543,289	$158,204,933
216-Z-1	Present Worth Cost	$0	$1,686,671	$3,261,314	$4,254,103	$0	$3,129,774	$3,129,774	$3,129,774
	Non-discounted cost	$0	$34,493,484	$36,068,128	$37,060,917	$0	$3,129,774	$3,129,774	$3,129,774
216-Z-2	Present Worth Cost	$0	$1,686,671	$3,261,314	$4,254,103	$0	$3,129,774	$3,129,774	$3,129,774
	Non-discounted cost	$0	$34,493,484	$36,068,128	$37,060,917	$0	$3,129,774	$3,129,774	$3,129,774
216-Z-3	Present Worth Cost	$0	$1,686,671	$4,394,669	$7,461,004	$0	$6,982,709	$6,982,709	$6,982,709
	Non-discounted cost	$0	$34,493,484	$37,201,483	$40,267,818	$0	$6,982,709	$6,982,709	$6,982,709
216-Z-9	Present Worth Cost	$0	$6,110,288	$13,254,499	$13,073,452	$0	$24,608,380	$41,748,953	$36,231,956
	Non-discounted cost	$0	$39,587,437	$49,267,509	$49,022,198	$0	$64,651,485	$55,436,895	$47,961,622
216-Z-12	Present Worth Cost	$0	$2,656,660	$11,116,199	$17,149,236	$0	$22,655,834	$22,655,834	$22,655,834
	Non-discounted cost	$0	$35,463,474	$43,923,013	$49,956,050	$0	$22,655,834	$22,655,834	$22,655,834
216-Z-18	Present Worth Cost	$0	$6,976,158	$32,288,189	$23,716,323	$0	$110,494,092	$166,365,197	$160,976,070
	Non-discounted cost	$0	$40,760,650	$75,550,481	$63,442,789	$0	$182,978,844	$230,382,769	$222,878,205

Table D-21. Present Worth Costs 200-PW-3 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Disounted Annual & Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-A-7	Crib	1	ET Monofill Barrier w/ BioBarrier	$723,203	$12,152,271	$12,875,473	$1,937,074
216-A-8	Crib	1	ET Monofill Barrier w/ BioBarrier	$862,535	$12,152,271	$13,014,806	$2,076,406
216-A-24	Crib	1	ET Monofill Barrier w/ BioBarrier	$1,161,092	$16,224,653	$17,385,745	$2,790,485
216-A-31	Crib	1	ET Monofill Barrier	$838,820	$12,152,271	$12,991,091	$2,052,691
UPR-200-E-56	Unplanned Release	1	ET Monofill Barrier w/ BioBarrier	$1,433,694	$19,085,432	$20,519,126	$3,354,984

Table D-22. Present Worth Costs 200-PW-3 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Disounted Annual & Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-A-7	Crib	3b	RTD(w/mixing) & ET Monofill Barrier	$1,214,800	$12,225,638	$13,440,438	$2,434,338
216-A-7	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$1,263,251	$12,225,638	$13,488,889	$2,482,789
216-A-8	Crib	3b	RTD(w/mixing) & ET Monofill Barrier	$1,877,632	$12,225,638	$14,103,271	$3,097,171
216-A-8	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$3,068,566	$12,225,638	$15,294,204	$4,288,105
216-A-24	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$6,262,597	$14,686,093	$20,948,690	$7,733,185
216-A-31	Crib	3c	RTD(w/mixing) & ET Monofill Barrier	$1,599,367	$12,152,271	$13,751,638	$2,813,238
UPR-200-E-56	Unplanned Release	3b	RTD	$8,605,105	$12,624,604	$21,229,709	$9,865,351
UPR-200-E-56	Unplanned Release	3c	RTD	$10,553,955	$12,624,604	$23,178,559	$11,814,201

Adjusted for FY09 G&A Change from 14.3 to 8.5

Table D-23. Present Worth Costs 200-PW-3 Summary

Net Present Worth Cost Estimates. (350 Years)					
WASTE SITE/GROUP		No Action	ALTERNATIVE 1: Capping and Institutional Controls	ALTERNATIVE 3B: Remove and Dispose with Capping and Institutional Controls	ALTERNATIVE 3C: Remove and Dispose with Capping and Institutional Controls
216-A-7 Crib	Present Worth Cost	$0	$1,937,074	$2,434,338	$2,482,789
	Non-discounted cost	$0	$12,875,473	$13,440,438	$13,488,889
216-A-8 Crib	Present Worth Cost	$0	$2,076,406	$3,097,171	$4,288,105
	Non-discounted cost	$0	$13,014,806	$14,103,271	$15,294,204
216-A-24 Crib	Present Worth Cost	$0	$2,790,485	$0	$7,733,185
	Non-discounted cost	$0	$17,385,745	$0	$20,948,690
216-A-31 Crib	Present Worth Cost	$0	$2,052,691	$0	$2,813,238
	Non-discounted cost	$0	$12,991,091	$0	$13,751,638
UPR-200-E-56 Unplanned Release [1]	Present Worth Cost	$0	$3,354,984	$9,865,351	$11,814,201
	Non-discounted cost	$0	$20,519,126	$21,229,709	$23,178,559

Table D-24. Present Worth Costs 200-PW-6 Alternative 1

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Discounted Annual & Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-Z-5	Two Cribs	1	Physical Barrier w/CDF Backfill	$1,188,632	$35,120,358	$36,308,990	$2,411,057
216-Z-8	French Drain	N/A	N/A	$0	N/A	N/A	N/A
216-Z-10	Well	1	Decommission	$162,017	$0	$162,017	$162,017
241-Z-10	Tank	N/A	N/A				

Table D-25. Present Worth Costs 200-PW-6 Alternative 2

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Discounted Annual and Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-Z-5	Two Cribs	2	ISV with RTD	$399,281	$35,120,358	$35,519,639	$1,621,705
216-Z-8	French Drain	N/A	No Action	N/A	N/A	N/A	N/A
216-Z-10	Well	N/A	No Action	N/A	N/A	N/A	N/A
241-Z-10	Tank	N/A	No Action	N/A	N/A	N/A	N/A

Table D-26. Present Worth Costs 200-PW-6 Alternative 3

Waste Site	Site Description	Alternative	Alternative Description	Total Capital Cost	Non-Disounted Annual & Periodic Cost	Non-Discounted Cost	Total Present Worth Cost
216-Z-5	Two Cribs	3a	RTD with TRU Waste & ET Monofill Barrier	$2,760,845	$35,120,358	$37,881,203	$3,983,269
216-Z-5	Two Cribs	3c	RTD with TRU Waste & ET Monofill Barrier	$2,975,960	$0	$2,975,960	$2,975,960
216-Z-5	Two Cribs	3d	RTD with TRU Waste & ET Monofill Barrier	$2,975,960	$0	$2,975,960	$2,975,960
216-Z-5	Two Cribs	3e	RTD with TRU Waste & ET Monofill Barrier	$2,975,960	$0	$2,975,960	$2,975,960
216-Z-8	French Drain	N/A	No Action	N/A	N/A	N/A	N/A
216-Z-10	Well	N/A	No Action	N/A	N/A	N/A	N/A

Table D-27. Present Worth Costs 200-PW-6 Summary

Net Present Worth Cost Estimates. (1000 Years)							
WASTE SITE/GROUP		No Action	ALTERNATIVE 1: Capping and Institutional Controls	ALTERNATIVE 2: ISV and Institutional Controls	ALTERNATIVE 3A: Remove and Dispose with Capping and Institutional Controls	ALTERNATIVE 3C,D,E: Remove and Dispose with Capping
216-Z-5	Present Worth Cost	$0	$2,411,057	$1,621,705	$3,983,269	$2,975,960
	Non-discounted cost	$0	$36,308,990	$35,519,639	$37,881,203	$2,975,960
216-Z-8	Present Worth Cost	$0	N/A	N/A	N/A	N/A
	Non-discounted cost	$0	N/A	N/A	N/A	N/A
216-Z-10	Present Worth Cost	$0	$162,017	N/A	N/A	N/A
	Non-discounted cost	$0	$162,017	N/A	N/A	N/A

Table D-28. Capital Costs Settling Tank Summary

Site	Description	Opt	Alternative	Mobilization/ Demobilization	Monitoring & Sampling	Site Work	Soil Excavation & Treatment	Site Improvements	Construction Staff	Subtotal	Contingency	Subtotal	Professional Mgmt	Remedial Design	Construction Mgmt	Total Project
241-Z-361	Sludge Tank	0	Alternative 3 - Drain TRU Waste and CDF backfill	-	-	584,300	9,884,628	-	-	10,468,928	5,757,910.24	16,226,837.96	811,342	1,298,147	973,610	19,309,937
241-Z-8	Sludge Tank	0	Alternative 3 - Drain TRU Waste and CDF backfill	-	-	24,600	7,611,163	-	-	7,635,763	4,199,669.84	11,835,433.18	591,772	946,835	710,126	14,084,165
														Total for both tanks		33,394,103

Table D-29. Groundwater Monitoring Costs for Each Closure Zone

Closure Zone	Number of Sites in Each Closure Zone	Cost per Site
200 East Area Ponds	50	$13,603 ($82,854)
PUREX	101	$6,734 ($40,883)
Plutonium Finishing Plant	40	$17,004 ($103,230)

Table D-30. Incremental Costs for Groundwater Sampling for Each Closure Zone

Closure Zone: 200 East Pond	**Cost per site: $13,603 ($82,854)**
216-A-7 Crib	216-A-8 Crib
216-A-24 Crib	UPR-200-E-56
Closure Zone: PUREX	**Cost per site: $6,734 ($40,883)**
216-A-31 Crib	
Closure Zone: Plutonium Finishing Plant	**Cost per site: $17,004 ($103,230)**
216-Z-1A Tile Field	216-Z-1 Crib
216-Z-2 Crib	216-Z-3 Crib
216-Z-9 Trench	216-Z-12 Crib
216-Z-18 Crib	214-Z-361 Tank
216-Z-5 Crib	216-Z-8 French Drain
216-Z-10 Injection/Reverse Well	241-Z-10 Tank